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CORRECTIONS

ERA Vol. 2, No. 24, Abst. 60196, line 3 should read: Vyssh. Uchebn. Zaved., Energ.; 20: No. 2, 42-48(1977).

ERA Vol. 3, No. 5, Abst. 9593, line 1 should read: (NP-22676) Catalytically activated gasification of coal

ERA Vol. 3, No. 7, Abst. 15285, line 3 should read: F.R.)). Fernwaerme Int.; 6: No. 3, 122-129(1977).

ERA Vol. 3, No. 7, Abst. 15286, lines 3-6 should read: Federal Republic of Germany. Stumpf, H. (WIBERA, Wirtschaftsberatung A.G., Duesseldorf (Germany, F.R.)). Fernwaerme Int.; 6: No. 3, 74-81(1977). (In German).

ERA Vol. 3, No. 7, Abst. 15287, lines 2-7 should read: environment. Lange, M.; Brocke, W. (Umweltbundesamt, Berlin (Germany, F.R.)). Fernwaerme Int.; 6: No. 3, 114-121(1977). (In German).

ERA Vol. 3, No. 7, Abst. 15288, lines 1-4 should read: Questions of temperature spread. Brumm, W. (Vereinigte Elektrizitaetswerke Westfalen A.G. (VEW), Dortmund (Germany, F.R.)). Fernwaerme Int.; 6: No. 3, 129-133 (1977). (In German).

ERA Vol. 3, No. 7, Abst. 15289, lines 2-6 should read: sions drawn from district-heating studies. Winkens, H.P. (Vereinigung Deutscher Elektrizitaetswerke e.V (VDEW), Frankfurt am Main (Germany, F.R.). Arbeitsgemeinschaft Fernwaerme e.V.). Fernwaerme Int.; 6: No. 3, 69-73 (1977). (In German).

ERA Vol. 3, No. 7, Abst. 15513, the correction published in *ERA* Vol. 3, No. 21 should be ignored.

ERA Vol. 3, No. 8, Abst. 19124, the correction published in *ERA* Vol. 3, No. 21 should be ignored.

ERA Vol. 3, No. 12, Abst. 29304, the correction published in *ERA* Vol. 3, No. 21 should be ignored.

ERA Vol. 3, No. 13, Abst. 31294, line 1 should read: (UCRL-52306(Vol.1)) Determination of the effectiveness

ERA Vol. 3, No. 21, Abst. 51354, lines 2-3 should read: concentration dependence of capture fractions. Leon, M. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). Phys. Rev., A; 17: No. 6, 2112-2115(Jun 1978).

ERA Vol. 3, No. 21, Abst. 51355, lines 2-8 should read: Wohlfahrt, H.D. (Los Alamos Scientific Lab., N. Mex (USA)). Shera, E.B.; Hoehn, M.V. Phys. Lett., B.; 73: No. 2, 131-134 (13 Feb 1978).

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Radioactivity in mixed oxide fabrication using LWR recycle plutonium. Final report, 3:262 (EPRI-NP-404)

Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.
Methods of compliance with fracture toughness and operational requirements of 10 CFR 50, appendix G, 3:639 (BAW-10046A(Rev.1))

Personal Authors

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Abey, A., *See* Schatz, J., 3:1561
Abey, A.E., Apparatus for deformation tests at intermediate strain rates—10^{-2} to 10^{-2} s^{-1}—and at high pressure, 3:1118 (UCRL-79012)
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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 820

PROCESSING

REFER ALSO TO CITATION(S) 1078

CARBONIZATION

1 **Quantitative description and modification of cocarbonization compatibility of pitch fractions.** Mochida, I.; Amamoto, K.; Maeda, K.; Takeshita, K. (Kyushu Univ, Res Inst of Ind Sci, Fukuoka, Jpn). *Fuel;* **57**: No. 4, 225-231(Apr 1978).

The cocarbonization properties of the benzene-soluble fractions (BS) of several pitches with benzene-insoluble fractions (BI) of SRC pitches were studied, changing their mixing ratio in order to evaluate their compatibility for needle-coke formation. The quantitative description of compatibility may be useful both for practical application and understanding the carbonization reactions. 16 refs.

2 **Strength of industrial cokes. VII. Further studies of the influence of additives in a coke-oven charge on the tensile strength of coke.** Patrick, J.W.; Stacey, A.E. (Br Carbonization Res Assoc, Chesterfield, Derbyshire, Engl). *Fuel;* **57**: No. 5, 258-264(May 1978).

The objective of this investigation was to determine if the previously established dependence of the tensile strength of coke on the breeze content and particle size of coke breeze in the coke-oven charge was applicable to different types of breeze additives when used in a size range similar to that of commercial practice. Using a small-scale oven to obtain the desired close control of the charge preparation and carbonization conditions, cokes were prepared from a Yorkshire strongly-caking coal blended with either coke-oven breeze, petroleum-coke breeze, or silica sand. The tensile strength of the cokes was determined by the diametral-compression test. The results confirm that the tensile strength of coke varies systematically with the coke-oven breeze content of the oven charge. 9 refs.

3 **Influence of heating-rate variation on the anisotropy of carbonized vitrinites.** Goodarzi, F.; Murchison, D.G. (Univ of Newcastle, Newcastle upon Tyne, Engl). *Fuel;* **57**: No. 5, 273-284(May 1978).

Six vitrinites of bituminous and anthracitic rank have been carbonized in nitrogen at three heating rates (1, 10 and 60°C/min) to temperatures between 20 and 950°C. The development of anisotropy, reflecting the growth and increased ordering of the aromatic lamellae of the chars, has been assessed by reflected-light microscopy. Rising the heating rate has its most pronounced effect in rapidly increasing the anisotropy of chars formed from vitrinites of medium-volatile bituminous rank. Fast heating rates have much less effect upon the anisotropy of chars from low-rank vitrinites and still less influence upon the anisotropy of chars formed from high-rank coking and anthracitic vitrinites, where the initial rank and the final carbonization temperature are much more important factors. The employment of fast heating rates to produce high levels of anisotropy in carbonized products for industrial processes, and the application of the data obtained in the current investigation to evaluate thermally metamorphosed coals in natural environments, are also briefly considered. 16 refs.

4 **Latent technological resources in the production of Dinas for coke ovens.** Tsigler, V.D.; Orlov, G.V.; Naginskii, M.Z.; Zhuravleva, Z.K. (Pervouralsk Dinas Plant, USSR). *Refractories (USSR) (Engl. Transl.);* **18**: No. 5-6, 323-326(May-Jun 1977).

The results are reported of an investigation of the variation of the density and after-expansion of Dinas brick with the proportion of grains of 3-2 mm in the batch and the amount of added iron oxides. 5 refs.

5 **Dry coke quenching: proved, profitable, pollution-free.** Kemmetmueller, R. (American Waagner-Biro Co., Inc., Pittsburgh). *Iron Steel Eng.;* vp(1973).

Environmental control and energy crisis have become household words in many industries and there is no doubt that the underlying problems are very serious, especially in the iron and steel industry and in the related coke industry. Considerable interest has been focused recently in the U.S., Europe and Japan on dry coke quenching because this technology offers significant advantages for coke plants in the field of pollution control as well as energy recovery. It is this combination—pollution control/energy recovery—that makes the process economically attractive. Few, if any, other pollution control technologies offer a return on the initial investment, i.e., most pollution control installations are nonrevenue producing and involve relatively high operating and maintenance costs. Dry coke quenching is not new. It is actually an old process developed shortly after World War I by Sulzer Brothers in Switzerland. Over 70 coke plants in gas works and some steel mills were equipped with dry coke quenching units up to 1950. Russia adopted the dry quenching technology in the early 1960's and has now made it mandatory for all new coke plants. There are to date 28 dry quenching units in operation in Russia, and 24 more under construction or in the design stage. The Russian units, as a rule, are larger than the other European units but follow essentially the same design and operating principles developed by Sulzer. Whereas the European installations were built primarily with the energy recovery aspects in mind, Russian sources indicate that the improved coke quality resulting from the dry quenching was, at least in the beginning, the driving force behind the adoption of the dry quenching technology. In the U.S., stringent air pollution regulations are probably the main reason more and more coke producers are looking into dry quenching, whereas the energy recovery, improved coke quality, etc., are considered as desirable side benefits.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 20, 80, 93, 94, 96, 98, 99, 100, 101

6 (FE—2295-32-2) **Medium and high temperature gas cleanup of particulates. Quarterly progress report, January—March 1978.** (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Apr 1978. Contract EX-76-A-01-2295-032. 9p. Dep. NTIS, PC A02/MF A01.

The modular sections of the test rig are in place. Installation of operating controls and instrumentation is under way. The first electrofluidized bed has been designed and its construction begun. Design of a flame charger has been started. Tests on materials to promote formation of stable agglomerates of fly ash were initiated. Late delivery of a control valve and a pressure transducer have slowed assembly of the test system, but we expect to be operating well before the end of the next reporting period.

7 (FE—2579-18, pp A1-A12) **Filter efficiency for clean static granular bed filters.** Goren, S.L. (Univ. of California, Berkeley). Jan 1978.

In Granular bed filter development program. Theoretical analysis of granular bed filtration principles and performance prediction.

The moving granular bed filter developed by Combustion Power Company operates with typical gas superficial velocities between 50 to 100 ft/min moving through a bed of spherical collec-

tors or grains 0.2 cm in diameter. Review of the literature disclosed very little data for filtration efficiency under these conditions. Accordingly, a separate experimental program was undertaken to measure the filtration efficiency for a range of parameters relevant to the moving granular bed filter. A solid, "non-sticky" aerosol was selected so that the present results would be directly comparable to Combustion Power Company's cold bed tests. This report summarizes the experimental procedure, gives the data measured, and gives separate equations for the capture efficiency due to impaction, gravity settling and Brownian diffusion.

8 (FE—2579-18, pp B1-B87) **Mathematical model for the moving granular bed filter.** Goren, S.L. (Univ. of California, Berkeley). Jan 1978.

In Granular bed filter development program. Theoretical analysis of granular bed filtration principles and performance prediction.

A mathematical model of granular bed filters is presented with the following caveat: Pressure drop and particle capture efficiency in moving granular bed filters depend on a large number of variables including gas volumetric flow rate and gas properties, particle size, shape, density and concentration, grain size and recirculation rate, rate of grain spillage through the louvers, and bed dimensions and geometry. In view of this complexity, reliance on theory alone for quantitative prediction of pressure drop and particle capture efficiency is unwarranted. Appropriate use of theory is to suggest qualitative trends and economical methods of correlating data in terms of the large number of variables that influence operation of such filters. Only if the model equations presented successfully forecast the trends qualitatively and successfully suggest correlating procedures should these equations be relied upon for the design or scale-up of moving granular bed filters.

9 Process for purifying raw gas from the gasification of solid fuels. Baron, G.; Bierbach, H.; Hafke, C. (to Metallgesellschaft AG). US Patent 4,087,258. 2 May 1978. Priority date 5 Feb 1975, German, Federal Republic of (F.R. Germany). 6p.

A process is disclosed for purifying raw gas produced by the gasification of solid fuels under superatmospheric pressure by treatment with gasifying agents containing water vapor and free oxygen. The raw gas contains dust and hydrocarbons and is at a temperature of 400 to 700°C as it leaves the gas producer. The raw gas is purified by spraying in at least two scrubbing stages with virtually dustfree, highly dispersed scrubbing water at temperatures of 160 to 300°C. In this manner, the gas is cooled to a temperature that is 0 to 20°C above the scrubbing water temperature and is saturated with water vapor in the scrubbing stages. Thereafter, the gas is subjected to centrifugal force to increase the relative velocity between gas and water droplets. The scrubbing water which contains dust and tar is withdrawn from each scrubbing stage. For the first scrubbing stage a cyclone-type scrubber can be used and for the second scrubbing stage a radial flow-type scrubber or a Venturi-type scrubber can be used.

10 Method for separating liquid and solid products of liquefaction of coal or like carbonaceous materials. Malek, J.M. US Patent 4,085,029. 18 Apr 1978. Filed date 12 Jan 1976. 4p.

A method is disclosed for improving the quality of slurry products taken from coal liquefaction reactors comprising subjecting the slurry to treatment with an alkaline compound such as caustic soda in the presence of steam in order to decompose the phenolic and acidic materials present in the slurry, and to also lower the slurry viscosity to allow separation of solid particles by sedimentation.

11 Effects of coal minerals on the hydrogenation, desulfurization, and solvent extraction of coal. Guin, J.A.; Tarrer, A.R.; Prather, J.W.; Johnson, D.R.; Lee, J.M. (Auburn Univ, Ala). *Ind. Eng. Chem., Process Des. Dev.;* **17**: No. 2, 118-126(Apr 1978).

The purpose of this study is to demonstrate that certain coal minerals catalyze the hydrogenation and hydrodesulfurization of creosote oil, a coal-derived solvent used as a start-up solvent in the Solvent Refined Coal (SRC) process; to show that by accelerating hydrogenation of process solvent such as creosote oil, coal mineral catalysis accelerates indirectly the rate of liquefaction of coal solids; and to provide better insight as to the process advantages and disadvantages of coal mineral catalysis. It is found that the rate-limiting step in the liquefaction of coal is the transfer of hydrogen to the donor solvent, and the rate of liquefaction increases with the concentration of coal minerals. Certain coal minerals also catalyze hydrodesulfurization of creosote oil--pyrite having a relatively insignificant effect on total hydrodesulfurization. The physical state, as well as chemical composition, of the coal minerals affect hydrogenation and hydrodesulfurization activity during coal liquefaction. 28 refs.

12 Process to remove iron sulfide from coal to reduce pollution. Colli, A.J. (to Secretary of the Navy). US Patent 4,081,251. 28 Mar 1978. Filed date 1 Oct 1976. 4p.

A method is described for reducing the amount of sulfur present in coal which comprises grinding the coal to less than 100 microns, physically separating the fine coal rich fraction from the coarse pyrite rich coal fraction, diluting the coarse pyrite rich coal fraction with a liquid hydrocarbon carrier and then separating the high pyrite coal from the low coarse pyrite coal by passing the particles through a magnetic separator.

13 Coal desulfurization process. Hsu, G.C.; Gavalas, G.R.; Ganguli, P.S.; Kalfayan, S.H. (to California Inst. of Tech.). US Patent 4,081,250. 28 Mar 1978. Filed date 27 Aug 1976. 8p.

A method of chlorinolysis of coal in an organic solvent at a moderate temperature and atmospheric pressure has been proven to be effective in removing sulfur, particularly the organic sulfur, from coal. Chlorine gas is bubbled through a slurry of moist coal in chlorinated solvent. The chlorinated coal is separated, hydrolyzed and then dechlorinated. Preliminary results of treating a high sulfur (4.77% S) bituminous coal show that up to 70% organic sulfur, 90% pyritic sulfur and 76% total sulfur can be removed. The treated coal is dechlorinated by heating at 500°C. The presence of moisture helps to remove organic sulfur.

14 Disposal of sulfur oxide pollutant-containing gas. Moss, G. (to Environmental Protection Agency). US Patent 4,081,513. 28 Mar 1978. Priority date 11 Dec 1974, United Kingdom of Great Britain and Northern Ireland (UK). 8p.

A pollutant such as SO_2 is removed from a pollutant-containing gas stream by passing the stream to a drying zone to which a solution and/or dispersion of pollutant-reactive material (such as CaO) is supplied, the drying zone operating to evaporate the liquid (e.g., water) and at least some pollutant reacting with the material to form an innocuous disposable solid which is removed, the pollutant-depleted gas stream being scrubbed in a scrubbing zone by a solution and/or dispersion of pollutant-reactive material to form substantially pollutant-free gas which is vented to atmosphere, the solution and/or dispersion being recovered from the scrubbing zone, some being recirculated back to the scrubbing zone after the addition of required make-up liquid and/or pollutant-reactive material, and some being passed to the drying zone preferably after concentrating the pollutant-reactive material therein. Preferably, the drying zone is a bed of solids fluidized by the incoming hot pollutant-containing gas stream.

15 Process for the beneficiation of solid fuel. Verschuur, E. (to Shell Oil Co.). US Patent 4,080,176. 21 Mar 1978. Priority date 24 Nov 1975, Netherlands. 4p.

The invention relates to a process for the beneficiation of solid fuel, in which a heat treatment at elevated pressure is applied to an aqueous suspension of the solid fuel in a finely divided form in the presence of an additive which, under the prevailing conditions, causes water-insoluble sulfur compounds to be converted into soluble compounds, after which fuel and water are separated.

16 Method for separating undissolved solids from a coal liquefaction product. Tan, G.; Gatsis, J.G. (to UOP Inc.). US Patent 4,079,005. 14 Mar 1978. Filed date 14 Dec 1976. 8p.

Production of a low mineral content fuel by a coal liquefaction process utilizing an asphaltene-free hydrogenated coal solvent which yields as the primary product a mixture of liquid and solids, a part of which is suspended in the liquid. The suspended solids are effectively removed with minimum loss of desired product by means of a light aromatic solvent in combination with a hydrogenated coal solvent, having been hydrogenated to remove at least about 80% of the asphaltenes.

17 Separation of insoluble material from coal liquefaction product by gravity settling. Snell, G.J. (to The Lummus Co.). US Patent 4,077,881. 7 Mar 1978. Filed date 8 Jul 1976. 6p.

Insoluble material is separated from a coal liquefaction product by gravity settling in the presence of a promoter liquid having specific characteristics, with a portion of the solid containing underflow being recycled to the gravity settler and introduced at a point above the introduction of the coal liquefaction product, with the respective points of introduction being separated by a distance of at least 0.1 H and no greater than 0.5 H wherein H is the total height of the gravity settler.

HYDROGENATION

REFER ALSO TO CITATION(S) 11, 112

18 (FE—2781-1) **Deuterium tracer method for investigating the chemistry of coal liquefaction. Quarterly technical progress report, October—December 1977.** Skowronski, R.P.; Ratto, J.J.; Heredy, L.A. (Atomics International Div., Canoga Park, CA (USA)). Mar

1978. Contract EF-77-C-01-2781. 37p. Dep. NTIS, PC A03/MF A01.

The objective of this research is to achieve a better understanding of the mechanism of coal hydrogenation. A deuterium tracer method is being developed to achieve that goal. Emphasis during this quarter has been placed upon conducting additional experiments with coal and deuterium to further elucidate this area of coal hydrogenation. Experiments were conducted to explore the reaction of coal under nitrogen pressure in the absence of deuterium, under deuterium pressure using the standard procedure, and under deuterium pressure using a special pretreatment procedure. The experiments were conducted under the same reaction conditions. The production of soluble products increased in the order of the experiments stated above. This suggests that the degree of contact of coal with gas-phase deuterium is important for the production of soluble products. As observed previously, the atom % deuterium content of the products increased in going from the oil fraction, to the asphaltene fraction, to the benzene-methanol soluble fraction, and finally to the insoluble residue. The nuclear magnetic resonance spectral data have not only given insight into the structural composition of the hydrogenation products, but also have indicated where gas-phase deuterium incorporation has occurred. Greatest relative deuterium incorporation was found in α-alkyl positions. The isotopic composition of the product gases indicates that the gas-phase hydrocarbons have a ratio of deuterium/protium that is lower than the ratio of deuterium/protium in the hydrogen cover gas. The gas chromatographic data indicate that the rates of the hydrodesulfurization reactions occurring are quite sensitive to the degree of contact opportunity between the gas-phase deuterium and the coal.

19 Catalytic hydrogenation of blended coal and residual oil feeds. Chervenak, M.C.; Johanson, E.S. (to Hydrocarbon Research, inc.). US Patent 4,054,504. 18 Oct 1977. Filed date 2 Oct 1975. 6p.

A process is provided for the simultaneous conversion of coal and residuum oil to predominantly liquid products, employing ebullated bed techniques. A fluid blend of particulate coal admixed with crude oil comprising from about 20 to 100% by weight of residuum oil boiling above about 975°F is contacted with hydrogen in the presence of an ebullated bed of particulate hydrogenation catalyst to effect conversion of at least about 50% of the residuum oil component and up to about 94% of the m.a.f. coal. In an alternate embodiment the oil feed includes recycled oil from the product liquids.

GASIFICATION

REFER ALSO TO CITATION(S) 9, 74, 92, 103, 109, 118, 172, 402, 406, 407, 547, 983, 1073

20 (ACD—38391-4) Investigation of high velocity wedge separator for particle removal in coal gasification plants. Phase I report. Linhardt, H.D. (Airco Cryogenics, Irvine, CA (USA)). 31 Jan 1978. Contract EF-77-C-01-2709. 102p. Dep. NTIS, PC A06/MF A01.

This report summarizes the results of Phase I of the High Velocity Wedge Separator Program performed under Contract EF-77-C-01-2709. Phase I is concerned with the conceptual design and feasibility study of a high velocity wedge separator, which could potentially reduce equipment size and cost of hot temperature particulate removal equipment for coal-derived gases. Using the Foster Wheeler two stage entrained flow gasifier as reference case, a preliminary evaluation of the feasibility and practicality of the conceptual design is considered. For this purpose, preliminary fluid flow analysis is conducted, the particle collection efficiency defined and potential erosion problems identified. Recommendations are presented for verifying the analysis by conducting an analog model investigation. The preliminary design of the experimental device is summarized, defining collection efficiency, overall pressure drop and general application to coal gasification processes of interest. The theoretical results indicate that a properly designed high velocity wedge separator can have a high collection efficiency with acceptable pressure drops. The wedge separator can be designed for any particle distribution inputs as available from pilot testing. The ambient model lends itself to the accurate measurement of particle distribution and detailed fluid mechanic optimization.

21 (ANL—78-54) Materials technology for coal-conversion processes. Thirteenth quarterly report, January—March 1978. Ellingson, W.A. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 126p. Dep. NTIS, PC A07/MF A01.

In the evaluation of ceramic refractories for slagging gasifiers preliminary results of run 6, 7 and 8 are presented. Several samples of slag and the slag outlet block were obtained from the Bi-Gas pilot plant in Homer City, PA, and analyzed. The slag outlet block showed only minimal corrosion in 114 h of operating time. The HYGAS external cyclone separator was again ultrasonically inspected after an additional 1092 hours of operation (total exposure now 3142 h). The erosive wear was significant and the unit will be inspected more frequently for optimizing replacement time. Additional results from ANL Instrumented Elbow II in the main coal feed line of the Synthane pilot plant after transfer of 133000 kg of coal indicated small amounts of erosive wear comparable to the error band of the field measurements (approximately 0.13 mm/measurement). Data from the Bi-Gas plant transfer lines have been refined by further measurements and analysis, and the amount of erosion appears to have been very small: techniques have been introduced to improve the measuring accuracy in order to detect the wall-thickness changes. Uniaxial tensile data were generated for Incoloy 800, Type 310 stainless steel, U.S. Steel Alloy 18-18-2, and Inconel 671 in the as-received condition and after 1000-h exposures to multicomponent gas mixtures that simulate a coal-gasification environment. The results, obtained at 871 and 750°C, showed a decrease in the flow stress of the material after exposure to complex gas mixtures, when compared with that of the as-received material. The erosion test apparatus was assembled for preliminary check out and room-temperature calibration. Failed components from the HYGAS Pilot Plant, the HYGAS Ash Agglomerating Gasifier, and the Grand Forks Energy Research Center were examined.

22 (ANL-FE—49622-TM02) Preliminary report on the flow no-flow indicator for the BI-GAS char line. Roach, P.D.; Raptis, A.C. (Argonne National Lab., IL (USA)). Jul 1978. Contract W-31-109-ENG-38. 16p. Dep. NTIS, PC A02/MF A01.

The BI-GAS coal gasification pilot plant at Homer City, Pa. has an urgent need for monitoring char flow to the gasifier. The feed lines contain finely divided char in a steam carrier and operate at 800°F and 1650 psi. A high temperature microphone, developed at ANL, has been installed in one char feed line with the goal of distinguishing between flow and no-flow conditions. The microphone signal is amplified and spectrum analyzed to reveal signal components associated with both char flow and steam flow. So far, we have obtained data only on the background steam noise, because operational problems at the pilot plant have delayed the start of char flow since our microphone was installed. The steam flow provides a strong microphone signal with a rich spectral content extending to about 45 kHz. Char flow data are scheduled to be taken during summer 1978.

23 (ANL/IAPE/TM—78-1) High-Btu gas supply systems: the characterization and social cost of selected options for providing gas to a midwestern terminus. Samsa, M.E.; Hub, K.A.; Evans, A.R. (Argonne National Lab., IL (USA)). Oct 1977. Contract W-31-109-ENG-38. 272p. Dep. NTIS, PC A12/MF A01.

This study identifies and compares the social costs of alternative methods of supplying incremental quantities of pipeline-quality gas to the Chicago-Northern Indiana area in the 1985 to 1990 time period: increased offshore production of nonassociated natural gas, imported liquefied natural gas, and first-generation Lurgi gasification of North Dakota lignite and southern Illinois bituminous coal. Reference systems, each supplying 250 million cubic feet of gas per day, are defined and characterized to allow comparison of the four options on an equivalent basis. The social costs emphasized are resource use, environmental residuals, conventional construction and operating costs, socio-economic impacts, and human health and safety impacts. Where possible, the social costs are quantified and presented side by side for the four reference systems.

24 (BMI-X—690) Gasification of dilute phase hydrogasification char. Final report. Longanbach, J.R. (Battelle Columbus Labs., OH (USA)). 8 Dec 1977. Contract W-7405-ENG-92-099. 37p. Dep. NTIS, PC A03/MF A01.

A modification of the Hydrane process concept involves the production of methane by direct hydrogasification of coal in a free fall, dilutphase reactor. The char produced in the first step is gasified with steam and oxygen in a separate reactor to produce hydrogen for the first stage. Hydrogen, carbon monoxide and carbon dioxide are produced in the steam gasification step and may interfere with the steam-char reaction. Lignite is also being used as a feedstock in the Hydrane Process and its behavior during steam gasification is of interest. A high-pressure, high-temperature thermobalance (TGA) was used to determine the rates of gasification in steam, steam-hydrogen, and Syngas mixtures of a lignite and an Illinois No. 6 char prepared in a single-stage, dilute phase hydrogasifier at the Pittsburgh Energy Research Center. Twenty experiments were completed. Comparison of the results using the single-stage hydrogasification char with earlier results, obtained under identical conditions using an Illinois No. 6 coal char prepared in the two-stage Hydrane process at PERC, shows that the single-stage char reacts slightly faster.

25 (CONF-780902—8) Peat hydrogasification. Weil, S.A.; Nandi, S.P.; Punwani, D.V.; Kopstein, M.J. (Institute of Gas Technology, Chicago, IL (USA)). 1978. Contract EX-76-C-01-2469. 13p. Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

The United States has recently recognized the potential of peat as a significant energy resource. In July 1976, the Institute of Gas Technology (IGT) started working on a peat gasification program jointly funded by the U.S. Department of Energy (DOE) and the Minnesota Gas Company (Minnegasco). The objective of this program is to obtain peat gasification data in laboratory-scale and in process development units and to evaluate the economics of converting peat into substitute natural gas (SNG). The reactor concept incorporates single-stage short-residence-time hydrogasification in dilute-phase cocurrent contacting, followed by a fluidized-bed char gasification with steam and oxygen. This paper presents the kinetic description of the process that accounts for the yields of light hydrocarbon gases, carbon oxides, and hydrocarbon liquids obtained during initial hydrogasification in the laboratory-scale equipment and in the Process Development Unit (PDU). The work was conducted as a part of the joint program between DOE and Minnegasco.

26 (COO—2904-9) **Chemical and physical stability of refractories for use in coal gasification. Ninth quarterly progress report, 1 May 1978—31 July 1978.** Rahman, S.F.; Day, D.E. (Missouri Univ., Rolla (USA)). 7 Aug 1978. Contract EY-76-S-02-2904. 16p. Dep. NTIS, PC A02/MF A01.

Activities are reported in a program to establish the corrosion resistance of refractories, especially the bond phases, to those high pressure/temperature gases and liquids typically present in coal gasification vessels. During this quarter, preparation and pre-exposure characterization of refractory and cement samples for an exposure test were completed. This test commenced on 7 July 1978 and the first two boehmite formation/decomposition cycles have been completed. Seven commercial and laboratory prepared cement-bonded castables and three calcium aluminate cements are being investigated currently. These materials and their chemical compositions are listed. In general, the insulating castables show smaller changes in modulus of rupture (MOR) than the dense castables after exposure to the cyclic conditions. The MOR of Cerlite 75 and VSL-50 remain nearly constant, with only Litecast 60-25 showing any major change in MOR and that is an increase. This behavior is consistent with results from earlier exposures in the DOE and CO/steam atmosphere.

27 (DOE/ET—0008/3) **Underground coal conversion program. Volume III. Resources.** (Department of Energy, Washington, DC (USA). Div. of Oil, Gas, Shale and In Situ Technology). Feb 1978. 211p. Dep. NTIS, PC A10/MF A01.

This volume identifies, characterizes, and quantifies United States coal resources that are of possible interest for underground coal gasification (UCG). The material presented can be used as a starting point for identifying candidate site areas, but it is not sufficiently detailed to be useful in the selection of specific sites. Section 1.0, the introduction, discusses geological and other factors affecting UCG site selection. It also explains why coal rank, seam thickness, and seam depth were selected as the preliminary screening criteria used to define UCG resources. Section 2.0 discusses eastern United States coal resources for UCG, and Section 3.0 discusses western states resources. Each state's resources that meet the preliminary screening criteria are discussed, with available tonnage estimates, chemical analyses, and information on depth, location, and thickness being included. Other data of possible use in evaluating resource suitability for UCG are also provided, and a subjective evaluation of each resource's potential suitability is made.

28 (DOE/ET—0024/2) **Coal gasification. Quarterly report, April—June 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion; Cameron Engineers, Inc., Denver, CO (USA)). Jan 1978. Contract EX-76-C-01-2297. 63p. Dep. NTIS, PC A04/MF A01.

The conversion of coal to high-Btu gas requires a chemical and physical transformation of solid coal. However, because coal has widely differing chemical and physical properties, depending on where it is mined, it is difficult to process. Therefore, to develop the most suitable techniques for gasifying coal, ERDA, together with the American Gas Association, is sponsoring the development of several advanced conversion processes. Although the basic coal-gasification chemical reactions are the same for each process, the processes under development have unique characteristics. A number of the processes for converting coal to high Btu and to low Btu gas have reached the pilot plant stage. The responsibility for designing, constructing and operating each of these pilot plants is defined and progress on each during the quarter is described briefly. The accumulation of data for a coal gasification manual and the development of mathematical models of coal gasification processes are reported briefly. (LTN)

29 (DOE/ET—0024/3) **Coal gasification. Quarterly report, July—September 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion; Cameron Engineers, Inc., Denver, CO (USA)). Feb 1978. Contract EX-76-C-01-2297. 70p. Dep. NTIS, PC A04/MF A01.

The conversion of coal to high-Btu gas requires a chemical and physical transformation of solid coal. However, because coal has widely differing chemical and physical properties, depending on where it is mined, it is difficult to process. Therefore, to develop the most suitable techniques for gasifying coal, ERDA, together with the American Gas Association, is sponsoring the development of several advanced conversion processes. Although the basic coal-gasification chemical reactions are the same for each process, the processes under development have unique characteristics. There are, for example, important differences in reactor configurations and methods of supplying heat for gasification. Moreover, because these processes require high temperatures and some require high pressures, temperature-resistant alloys and new pressure vessels must be developed to obtain reliable performance. A number of the processes for converting coal to high-Btu and to low-Btu gas have reached the pilot plant stage. The responsibility for designing, constructing and operating each of these pilot plants is defined and progress on each during the quarter is described briefly. The accumulation of data for a coal gasification manual and the development of mathematical models of coal gasification processes are reported briefly. (LTN)

30 (DOE/ET—0027/1) **Coal demonstration plants. Quarterly report, January—March 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion; Cameron Engineers, Inc., Denver, CO (USA)). Dec 1977. Contract EX-76-C-01-2298. 30p. Dep. NTIS, PC A03/MF A01.

The objective of ERDA's demonstration program is to establish the technical and financial feasibility of coal conversion technologics proven during pilot plant testing. Demonstration plants will minimize the technical and economic risks of commercialization by providing a near commercial size plant for testing and production. Thus, ERDA is sponsoring the development of a series of demonstration plants, each of which will be a smaller version of commercial plants envisioned for the 1980's. These plants will be wholly integrated, self-sufficient in terms of heat generation, and dependent only on feedstock of coal, water, and air. Under the ERDA program, contracts for designing, constructing, and operating the demonstration plants will be awarded through competitive procedures and will be jointly funded. The conceptual design phase will be funded by the government, with the detailed design, procurement, construction, and operation phases being co-funded, 50% from industry and 50% from the government. The cost involved in building and operating a demonstration plant will probably be between $200 million and $500 million, depending on the size of the plant. The processes to be demonstrated include the conversion of coal to liquid fuels, high-Btu gaseous pipeline fuels, and low-Btu fuel gas. Other processes will be demonstrated as they become available. Two of these demonstration plant projects are described briefly, including progress in the quarter. Certain support and technical assistance operations are described, in particular several coal feeder development programs for coal gasification plants. (LTN)

31 (DOE/ET—0027/2) **Coal demonstration plants. Quarterly report, April—June 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion; Cameron Engineers, Inc., Denver, CO (USA)). Jan 1978. Contract EX-76-C-01-2298. 47p. Dep. NTIS, PC A03/MF A01.

The objective of DOE's demonstration plant program is to establish the technical and financial feasibility of coal conversion technologies proven during pilot plant testing. Demonstration plants will minimize the technical and economic risks of commercialization by providing a near commercial size plant for testing and production. Thus, DOE is sponsoring the development of a series of demonstration plants, each of which will be a smaller version of commercial plants envisioned for the 1980's. These plants will be wholly integrated, self-sufficient in terms of heat generation, and dependent only on feedstock of coal, water, and air. Under the DOE program, contracts for designing, constructing, and operating the demonstration plants will be awarded through competitive procedures and will be jointly funded. The conceptual design phase will be funded by the government, with the detailed design, procurement, construction, and operation phases being co-funded, 50% from industry and 50% from the government. The cost involved in building and operating a demonstration plant will probably be between $200 million and $500 million, depending on the size of the plant. Six of these demonstration plant projects are described and progress in the quarter is summarized. Several support and complementary projects are described (fuel feeding system development, performance testing and comparative evaluation, engineering support, coal grinding equipment development and a critical components test facility). (LTN)

32 (DOE/ET—0027/3) **Coal demonstration plants. Quarterly report, July—September 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion; Cameron Engineers, Inc.,

Denver, CO (USA)). Feb 1978. Contract EX-76-C-01-2298. 79p. Dep. NTIS, PC A03/MF A01.

The objective of DOE's demonstration plant program is to establish the technical and financial feasibility of coal conversion technologies proven during pilot plant testing. Demonstration plants will minimize the technical and economic risks of commercialization by providing a near commercial size plant for testing and production. Thus, DOE is sponsoring the development of a series of demonstration plants, each of which will be a smaller version of commercial plants envisioned for the 1980's. These plants will be wholly integrated, self-sufficient in terms of heat generation, and dependent only on feedstock of coal, water, and air. Contracts for designing, constructing, and operating the demonstration plants will be awarded through competitive procedures and will be jointly funded. The conceptual design phase will be funded by the government, with the detailed design, procurement, construction, and operation phases being co-funded, 50% from industry and 50% from the government. The cost involved in building and operating a demonstration plant will probably be between $200 million and $500 million, depending on the size of the plant. Twenty-two projects involving demonstration plants or support projects for such plants are reviewed, including a summary for each of progress in the quarter. (LTN)

33 (DOE/ET—2606-2) **Development of automated welding processes for field fabrication of thick-walled pressure vessels: electron beam method. Second quarterly report, 1 January—31 March 1978.** Weber, C.M. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.). 1978. Contract EX-77-C-01-2606. 44p. Dep. NTIS, PC A03/MF A01.

A project to develop and demonstrate an electron beam welding procedure for welding 8" thick SA387 Grade 22 Class 2 (2¼ Cr—1 Mo) steel is reported. The progress made during the period January-March 1978 is summarized. The steel ordered for use in the project has not yet been received, which has resulted in a delay of the scheduled work. A procedure for eliminating unwanted displacements of the electron beam and the electron beam weld arising from magnetic fields was developed. A magnetic shield was designed, fabricated, and shown to be effective at protecting the electron beam from magnetic fields between the steel plate and the electron gun. Magnetic fields existing within the steel plate were shown to be of no concern.

34 (EPRI-AF—880) **Preliminary design study for an integrated coal gasification combined cycle power plant. Final report.** Grisso, J.R.; Barrett, D.E.; Bisserier, J.; Black, C.L.; Ferry, L.N.; Ide, Y.; Johnson, E.A.; Klumpe, H.W.; Stanbridge, D.W.; Yeung, S.S. (Parsons (Ralph M.) Co., Pasadena, CA (USA)). Aug 1978. 250p. Dep. NTIS, PC A11/MF A01.

This report presents the preliminary design, implementation schedules, and cost data for a fully integrated coal gasification/combined cycle power plant using the oxygen-blown Texaco Coal Gasification Process. The plant will have a net electrical output of 92 MW, and will be located at Southern California Edison Company's Coolwater Generating Station near Barstow, California. Three approaches for implementation of the plant were investigated: (1) Proceed initially with construction of the fully integrated plant; (2) proceed initially with construction of the coal gasification facility coupled to a new combustion turbine-generator only; and (3) proceed initially with construction of the coal gasification facility only, with the product gas fired in an existing boiler. In the latter two cases, the additional power-generation equipment required to complete the combined cycle would be added after a one-year testing program in the initial configuration. Cost estimates and schedules are presented for each of these three approaches to implementation. The report includes general arrangement drawings and complete performance and emissions data for the plant. Process flow diagrams, equipment lists, and system descriptions are presented for major systems in the plant.

35 (FE—1521-25) **Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, Phase II. Design report. Volume 6. Section 400: sulfur recovery.** (Foster Wheeler Energy Corp., Livingston, NJ (USA)). 1978. Contract EX-76-C-01-1521. 122p. Dep. NTIS, PC A06/MF A01.

Section 400 of the Coal Gasification/Combined Cycle Pilot Plant is designed to recover 1355 lb/h of molten sulfur by the Claus process. The sulfur is recovered from the sour water stripper gas of Section 200 (Water Wash, Sour Water Stripping, and Sludge Removal Unit) and from the acid gas of Section 300 (Selexol Unit). The unit basically consists of the following major components: an air blower, an air and acid gas preheater, a muffle furnace, a waste heat exchanger, four reactors and four condensers, three reactor feed heaters, a sulfur pit and a sulfur storage tank, a sulfur scrubber, and three sulfur pumps.

36 (FE—1521-57) **Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant: Phase II. Quarterly technical progress report, January—March 1978.** Smith, D.E. (Foster Wheeler Energy Corp., Livingston, NJ (USA)). May 1978. Contract EX-76-C-01-1521. 16p. Dep. NTIS, PC A02/MF A01.

The process specifications for most items have been issued, and most of the equipment is being designed and priced by vendors. The purchase order to Petrocarb, Inc., for the design of the coal, recycled-char, and limestone feeding systems has been issued. They have completed work on the process schematic drawings and have sized all of the equipment. Work on the piping and instrumentation diagrams has also been completed, and they have delivered the vessel sketches to FWEC. A requisition for the instrumentation package is being prepared and will be issued shortly. This package will define the instrumentation hardware required to measure the various operating parameters inside the Gasifier and will provide the cost estimates for this hardware. The Gasifier is currently being designed, and price quotations will be solicited shortly. Work has continued on the preparation of engineering flowsheets for the coal-handling, -pulverization, and -drying systems. Williams Patented Pulverizer Company is preparing a proposal that will provide the utility needs, an equipment list, and a cost estimate for the coal-pulverization and -drying systems.

37 (FE—1521-62) **Development work for an advanced coal gasification system for electric power generation from coal directed toward a commercial gasification generating plant, Phase II. Quarterly technical progress report, April—June 1978.** Smith, D.E. (Foster Wheeler Energy Corp., Livingston, NJ (USA)). Jul 1978. Contract EX-76-C-01-1521. 7p. (FWC/FWEC/GQ—012). Dep. NTIS, PC A02/MF A01.

Engineering flow sheets showing only major piping and equipment sizes have been issued in preliminary form. The process specifications for all remaining equipment items were issued for the ¾-t/h coal feed rate. Most of this equipment is being designed and priced by vendors. FWEC advised DOE personnel at a project review meeting that the ¾-t/h coal feed rate would produce a gas with a very low heating value and proposed design changes to produce a gas similar to commercially produced gas: Increase the coal capacity of the gasifier to 2½ t/h; increase gasifier design pressure to 400 lb/in.^{2} to permit handling of a coal feed rate of 5-t/h; and combine the limestone and slag feeding systems. The process-flow diagrams and equipment list were revised to reflect the new coal feed rate. Work has begun on revising equipment sizes, specifications, prices, plot plan, and elevations. A utility flow diagram showing the following systems has been prepared: cooling water, cooling and quench-water, LPG supply, nitrogen supply, synthesis gas supply, high-pressure steam, low-pressure steam, plant air and instrument air. The required horsepower has been tabulated and electrical design work has begun. Contracts have been made with local suppliers of char, limestone, and slag, and satisfactory arrangements have been made to assure an adequate supply of raw materials is maintained.

38 (FE—1545-47) **Test program for low-Btu gasification of coal for electric power generation. Final report, R and D task 14 (Phase I).** Simon, J.J. (Combustion Engineering, Inc., Windsor, CT (USA)). Nov 1977. Contract EX-76-C-01-1545. 106p. Dep. NTIS, PC A06/MF A01.

A test program was developed to demonstrate the capability and suitability of the process and equipment to produce a low-Btu gas of the predicted composition, heat content and cleanliness from the design coal. This program included both parameter operation and sustained operation periods to provide the design information to enable scale-up of the equipment to commercial size designs.

39 (FE—1775-15) **Coal conversion applications. Collected works, 1972-1977.** (Parsons (Ralph M.) Co., Pasadena, CA (USA)). Feb 1978. Contract EX-76-C-01-1775. 643p. Dep. NTIS, PC A99/MF A01.

From 1972 to the present, The Ralph M. Parsons Company has been assisting the Government in defining and developing commercially attractive coal conversion technology. In the course of this association, Parsons has produced some 53 reports, presentations, and publications supporting the OCR-ERDA-DOE programs. This publication presents in one volume the key published material. Five of the documents (Collected Works No. 12, 16, 20, 21, and 23) are major design/economic evaluation reports completed to fulfill contractual obligations, but because of their physical size, only the cover page, Introduction and Summary, and material balances are included in this book. Complete copies of these reports may be ordered from the National Technical Information Service. The remaining articles were prepared in response to invitations to submit the results of Parsons research. They include presentations at conferences and reprints from technical journals and books. All were intended to place pertinent information into the published literature at the earliest possible date. The present volume is an interim document, for

work continues on coal conversion technology and attendant economical and environmental assessments.

40 (FE—1784-36(App.)) **Program to discover materials suitable for service under hostile conditions obtaining in materials for the gasification of coal and other solid fuels. Appendices. Supplement to annual progress report, 1 January—31 December 1977.** (Metal Properties Council, Inc., New York (USA)). 7 Feb 1978. Contract EX-76-C-01-1784. 280p. Dep. NTIS, PC A13/MF A01.

This "Appendix" contains data generated by the testing program as well as minutes of monitoring committee meetings. Finally, a list of the total membership of Subcommittee 9 is given.

41 (FE—2275-7) **Systems studies of coal conversion processes using a reference simulator. Quarterly report, 1 January—31 March 1978.** Reklaitis, G.V.; Sood, M.K.; Raghavan, S.; Overturf, B.W.; Fazzoni, G.F.; Ford, J.R. (Purdue Univ., Lafayette, IN (USA)). Apr 1978. Contract EX-76-C-01-2275. 76p. Dep. NTIS, PC A05/MF A01.

Work has been completed on the final versions of the process block energy balancing program EBP-II, the rudimentary flowsheet graphics program PFS-I, as well as on the acid gas system model. The latter model successfully tested the integrated operation of the Simulation System, including the physical properties and equipment costing subsystems. The model itself was shown to generally give designs comparable to several reported in the literature. The costs calculated for various equipment items were shown to compare favorably to independently reported costs for similar equipment. A complete model has been prepared of a fixed bed oil hydrotreating reactor and all necessary model parameters have been estimated from COED data. An integrated flowsheet model of the pyrolysis, gasification, and combustion units has been implemented; however, further work is continuing on the reactor models themselves. The physical properties package has been updated to estimate petroleum fraction properties. A data validation routine has been added to the S^4 System and features have been implemented to accommodate solids and pseudo-component flows. Drafts of manuals of the S^4, EBP-II, PPROPS and SS/PP programs have also been prepared.

42 (FE—2338-9) **Development of a modular software system for the dynamic simulation of coal conversion plants. Quarterly report, January—March 1978.** Schiesser, W.E.; Stein, F.P.; Johnson, S.H.; Caram, H.S.; Shah, M.; Dissenger, G.R. (Lehigh Univ., Bethlehem, PA (USA)). Apr 1978. Contract EX-76-C-01-2338. 39p. Dep. NTIS, PC A03/MF A01.

The previously reported problems with option MF = 22 (banded approximation of the Jacobian matrix option) of the GEARB integrator have been corrected through assistance from Dr. A. C. Hindmarsh of Livermore. Thus, two stiff options of GEARB, MF = 22 and 23, are now operational within DDS/2 so that a degree of flexibility is available if needed in subsequent dynamic simulation studies. The representation of spatial derivatives in PDEs for flow systems, e.g., a tubular reactor, has been substantially improved through the general technique of upwind (noncentral) finite difference approximations. The four boilers in the methanation section have each been modeled as four stirred tanks on the gas side, each of which is in thermal contact with a constant-temperature sink at the temperature of the saturated steam. The hydroreactor has been modeled as an adiabatic, fixed-bed, catalytic, plug-flow reactor using one PDE for temperature from the energy balance and 21 ODEs for chemical species. A dynamic model for the three-stage pyrolysis system has been developed and coded. The model utilizes the distributed activation energy concept for the seven pyrolysis reactions considered. The resulting set of equations is very stiff. Further work has been done on the gasifier-combustor section to complete and refine the model. A preliminary run is presented which shows some of the characteristics of the dynamic response of the system.

43 (FE—2361-23) **Development of a fast fluid bed gasifier: Phase I, Task II. Quarterly progress report, October—December 1977.** Molayem, B.; Koziel, M. (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)). Apr 1978. Contract EX-76-C-01-2361. 30p. Dep. NTIS, PC A03/MF A01.

Hydrocarbon Research, Inc., in accordance with a DOE contract, is developing a coal gasifier for low Btu gas utilizing the principle of a fast fluid bed unit operation. Fast fluidization is a technique for bringing gas at high velocity into intimate contact with solids characterized by extreme turbulence and extensive refluxing of dense packets and strands of particles. This technique as applied to gasification of coal offers several important advantages over the conventional, low-velocity, bubbling fluidized beds, such as: Higher coal feed capacity, better gas-to-solid contacting, no coal pretreatment required prior to gasification, better turndown capability, more uniform temperature throughout the reactor, and operation at higher temperatures (no tars produced). The objective of the present contract is to demonstrate the technical viability of coal gasification to char in the fast fluid bed. Task II of the program, now in progress, is the procurement and construction of the experimental gasifier system.

44 (FE—2414-7) **Remote electromagnetic sensing of underground coal burns. Quarterly technical progress report, December 1977—February 1978.** Quincy, E.A. (Wyoming Univ., Laramie (USA). Dept. of Electrical Engineering). Mar 1978. Contract EX-76-S-01-2414. 17p. Dep. NTIS, PC A02/MF A01.

The main objective of this research project is to develop and field test an induction system and estimator algorithm for remote determination (at the surface) of the location, shape and size of underground coal burn regions. Field data taken at three different times during a yearly period for Hanna II, Phases 2 and 3, was compared showing definite site aging characteristics. These were probably due to temperature changes in the burn region and dispersion of conducting char and ash by ground water. Minimum mean-square-error length and width estimates of a buried conducting box model were obtained for field measurements at Hanna II, Phases 2 and 3. Preliminary investigations have shown that an excellent fit of the data can be obtained at a feasible depth by assuming approximately a fifty percent larger mean length and width.

45 (FE—2468-24) **ESCOE engineering program. Quarterly report, December 1, 1977—February 28, 1978.** Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Apr 1978. Contract EF-77-C-01-2468. 19p. Dep. NTIS, PC A02/MF A01.

ESCOE's engineering program is discussed from the point of view of several tasks: providing an energy information center for ESCOE and USDOE; comparative evaluation of coal gasification and liquefaction processes, with special emphasis on accurate and comparable capital costs of plants (since capital is a major factor of total cost); optimization of reactor conditions in the various process demonstrations; materials for coal conversion plants; fuel cell processing; computer-aided design (support for ASPEN); economics and feasibility of retrofitting plants to coal (on a regional basis); and the review of non-fossil energy R and D to determine the feasibility of technology transfer or joint programs. (LTN)

46 (FE—2469-25) **Experimental program for the development of peat gasification. Interim report No. 4. Physical properties evaluation: Task 1.** (Institute of Gas Technology, Chicago, IL (USA)). Apr 1978. Contract EX-76-C-01-2469. 72p. Dep. NTIS, PC A04/MF A01.

This interim report presents the results of tests conducted to determine the physical properties of Minnesota reed sedge peat which might be needed in developing a model for peat gasification, selecting the gasification process most suitable for peat, and determining the economics of such a process. The tests were conducted with Wilderness Farm reed sedge peat, selected as a representative Minnesota peat on the basis of numerous chemical analyses of peats from various locations. The tests were conducted to determine the grinding, fluidizing, and slurrying characteristics of peat and to investigate the effects of wet-carbonization and high-pressure compaction on its physical properties. Finally, peat briquettes and pellets were made and their strengths and attrition resistances were evaluated. The results of these tests show that: Conventional hammer mills can be used for grinding air-dried (40 weight percent moisture) peat; dried and ground peat can be fluidized; grinding and drying of peat reduces its liquid-retention capacity; a peat-toluene slurry containing 30 to 35 weight percent peat is pumpable; high-pressure compaction is effective in dewatering raw and wet-carbonized peat to 60 to 65 and 50 to 55 weight percent water, respectively; air-dried peat (35 weight percent moisture) can be briquetted or pelletized without binders; and the angles of internal friction, repose, slide, and rupture for dry peat are similar to those of coal. The physical properties of peat mentioned above suggest the possibility of peat gasification in fluidized-bed as well as in moving-bed reactors. These properties also suggest that peat could be fed to a high-pressure gasifier using either a lockhopper or a light-oil slurry system.

47 (FE—2518-20) **Hydrogasifier development for the Hydrane process. Monthly progress report, May 1978.** Combs, L.P.; Greene, M.I. (Cities Service Research and Development Co., Cranbury, NJ (USA); Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). Jun 1978. Contract EF-77-C-01-2518. 14p. Dep. NTIS, PC A02/MF A01.

Testing of the 1/4 TPH hydrogasifier reactor in the Rocketdyne 1-TPH hydroconversion facility was the only experimental effort pursued during May. The emphasis on this subtask is on longer duration (1 to 8 hours) runs with bituminous coals reacted under conditions yielding no liquid hydrocarbon products and with H_2/CH_4 feed gas mixtures to simulate partial recycle of product gases. However, testing was plagued by a succession of experimental problems that prevented achieving any long-duration runs. Work on the process design and economic study was concerned with investigating alternate hydrogen/methane separation processes. Preliminary investigation suggests that a moving bed activated carbon

adsorber may have significant economic advantages. In furthering the development of the entrained flow hydrogasifier reactor model, the coefficients for Anthony's coal particle hydropyrolysis model were rederived by multiple regression curve fitting of his experimental data. Although the new coefficients differ considerably from his values, their use did not improve the model's ability to calculate overall carbon conversions that compare well with actual values measured in ¼ TPH tests of bituminous coals.

48 (FE—2592-6) **Development of coatings for corrosion erosion protection of internal components of coal gasification vessels. Quarterly report, January 1—March 31, 1978.** Packer, C.M.; Clark, P.R.; Perkins, R.A. (Lockheed Palo Alto Research Labs., CA (USA)). 13 Apr 1978. Contract EF-77-C-01-2592. 96p. Dep. NTIS, PC A05/MF A01.

Studies included evaluation of the effectiveness of $M_1CrAlHf$ coatings in protecting stainless steel from corrosion in coal gasification atmospheres. The M_1 elements considered were Nb, Co, Mo, Ti, and V and the composition levels were of the order 22-28Cr, 4-12Al, and 0.2-1Hf. The coatings were deposited using slurry fusion, plasma spraying, flame spraying, and laser surface fusion techniques. Analyses after 96-h exposures to a coal gasification atmosphere at 1800°F indicated that all compositions had the potential for corrosion resistance independent of the M_1 element. Coating structure was found to be the most significant factor influencing performance, that is, the performance was sensitive to defects in the form of porosity or fissures. Considering the type of coating structure required for effective performance and the scale-up of cost-effective processes to coat large components, laser surface fusion appears to offer excellent promise as a coating deposition method.

49 (FE—2798-46) **Test and evaluate the TRI-GAS low-Btu gasification process. Quarterly report, January—March 1978.** (Bituminous Coal Research, Inc., Monroeville, PA (USA)). Apr 1978. Contract ET-78-C-01-2798. 22p. Dep. NTIS, PC A02/MF A01.

Three tests were conducted in the Stage 1 reactor to investigate the products of devolatilization from pretreatment of Illinois No. 6 seam coal. In March, testing was postponed because of local restrictions on electric power usage. The results of Test No. 3S-13 showed that no condensation was evident in the product gas lines. However, agglomerates formed as a result of a decrease in fluidizing velocity. During Test No. 3S-14, there was some difficulty withdrawing char through the solids control valve, LV101. Modifications were made to the withdrawal line and no difficulty was encountered during Test No. 3S-15. Laboratory tests were conducted to determine the fluidizing characteristics and reactivity of the char from Test No. 3S-15. Other tests in the laboratory reactors showed that the products of devolatilization can be treated in a simulated Stage 2 reactor.

50 (FE-MIT—2295T26-5) **Basic studies of coal pyrolysis and hydrogasification. Quarterly progress report, January 1, 1978—March 31, 1978.** Bush, T.W.; Denholm, D.; Dolan, J.; Franklin, H.; Howard, J.B.; Kenda, S.; Mead, D.; Peters, W.A. (Massachusetts Inst. of Tech., Cambridge (USA)). May 1978. Contract EX-76-C-01-2295-026. 23p. Dep. NTIS, PC A02/MF A01.

In order to be able to investigate the effect of particle size on pyrolysis and hydropyrolysis, coal samples of different diameter but of essentially the same composition must be used. Criteria for compositional invariance employed in this work include constancy of ash and maceral analysis. Work during this quarter focused primarily on establishing a technique for producing size fractions of essentially constant ash content. Results from maceral analysis will be reported later. A continuing effort has been made to identify and quantitatively analyze the volatile products recovered from cryogenic gas traps downstream of the flow reactor. The products are eluted from the cryo-traps into a temperature-programmable gas chromatograph equipped with flame ionization and thermal conductivity detectors. The following gases and liquids are now identified by their characteristic retention times under these conditions: carbon monoxide, methane, carbon dioxide, ethylene/acetylene, ethane, ammonia, hydrogen sulfide/water, carbonyl sulfide, propylene, propane, hydrogen cyanide, the butane isomers, methylene chloride, carbon disulfide, benzene/thiophene, and toluene. All of these compounds except ammonia have been observed on actual coal runs. The pyrolysis behavior of fairly high ash samples (approximately 20.1 percent) of 45 to 53 μm Pittsburgh No. 8 seam bituminous coal has been studied over the temperature range 600 to 1100°C under laminar entrained flow conditions and the results are summarized. Preliminary characterization of the mineral matter in coal was obtained by both x-ray diffraction and instrumental neutron activation analysis.

51 (ORNL/TM—6425) **Cladding of pressure vessel steels for coal conversion applications: a literature review.** Edmonds, D.P. (Oak Ridge National Lab., TN (USA)). Sep 1978. Contract W-7405-ENG-26. 47p. Dep. NTIS, PC A03/MF A01.

The available literature is reviewed concerning corrosion-resistant lining of large ferritic steel vessels and piping, applicable to coal gasification and liquefaction systems. Potential ferritic steel pressure vessel and piping materials are discussed along with potential stainless steel and nickel-base cladding materials. The various lining techniques currently used in the United States and abroad are also reviewed, with advantages and disadvantages of each. Materials problems with the various techniques are described. Several methods are available to produce ferritic steel components lined with corrosion-resistant layers. For low-temperature-low-thermal cycling applications, applied linings may be a good choice. However, for more critical applications, integral cladding is generally preferred. Integral cladding may be performed by a variety of methods, including solid state cladding, braze-bond cladding, and weld overlay (fusion) cladding. The lining process should be chosen after careful consideration of base metals and cladding metals desired and of the service requirements for the lined component.

52 (SAN—1472-9(App.C)) **Underground gasification for steeply dipping coal beds. Phase I report: Appendix C. Parametric cost estimate, September 30, 1977—February 28, 1978.** (Gulf Research and Development Co., Pittsburgh, PA (USA); TRW, Inc., McLean, VA (USA). Energy Systems Planning Div.). May 1978. Contract EF-77-C-03-1472. 46p. Dep. NTIS, PC A03/MF A01.

Gulf Research and Development Company has developed a proprietary computer program to calculate economics for a conceptual commercial UCG plant as applied to horizontal coal seams. The present program cannot provide steeply dipping bed (SDB) economics. However, various factors related to the coal seam, to operating conditions, and to process results may be independent of whether the coal bed is horizontal or tilted. A number of factors have been varied over a considerable range to show their effect on economics for a horizontal bed application. These results should be helpful in designing experimental field studies in steeply dipping beds. The computer calculations show that the most effective way to reduce the cost of gas from UCG is to increase its heating value. This decreases the plant size, number of wells, coal consumed, and fuel requirements. The next most effective ways are to increase product gas recovery and air utilization, i.e., to minimize leakage. To express these effects in another way, each 2 percent increase in either air or gas leakage increases the sales gas price by 1 percent. Also, decreased leakage results in smaller plants, fewer wells, less coal consumption, and lower fuel requirements all of which reduce final costs. An increase of 50 percent in either the methane or the hydrogen content of the product gas has about the same effect on sales gas price. The decrease in price is due to the increase in heating value of the gas. The essential element appears to be increased heating value and the manner in which this is accomplished does not greatly matter from a cost per unit of heat standpoint. Increased production wellhead pressure has a beneficial effect on gas price because the conceptual plant design requires that the production gas be compressed to 1135 kPa (150 psig) for pipelining to the main plant. The remaining parameters have only moderate effects on the gas price.

53 (SAND—78-0591C) **Parameter estimation applied to thermal data from in situ coal gasification experiments.** Hommert, P.J. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 16p. (CONF-781003—1). Dep. NTIS, MF/A01.

From 53. technical conference and exhibition; Houston, TX, USA (1 Oct 1978).

Portions of document are illegible.

Parameter estimation techniques that allow quantitative treatment of thermal data from an in situ coal gasification experiment are presented. After a discussion of the important aspects of using parameter estimation, the specific models used for the Hanna II and Hanna IV test data are outlined. In particular, conduction models have been useful for describing the reverse combustion process and a formal mapping procedure has provided quantitative detail of cavity growth during forward gasification.

54 (UCID—17832) **Review of previously published experimental data from Mars Research Center, Poland.** Olness, D.U. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Jun 1978. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

An analysis is presented of underground coal gasification experiments. All findings support the conclusion that the gasification zone was localized within a very short section of the channel, a section about 5 m long. The high temperatures in the reaction zone caused an increase (with respect to air blast) in the rate of chemical reactions. Free oxygen was used up over a short section of the fire channel without being able to penetrate deeper into the coal. As the gasification front moved on, the temperature in the channel gradually decreased behind the fire front, reaching its lowest value near the injection point. The slag-filled channel created something like an insulating zone which checked the radiation of heat from the fire front, thus maintaining high temperatures at the fire front. Gasification of hard coal with air did not yield favorable results because low temperatures caused an extension of the gasification zone, along the length of the channel and laterally as well. A long gasification zone

favors the burning of gas in the channel. Low temperatures favor the propagation of coal-oxidizing reactions laterally into the coal, causing a broadening of the fire channel. The heating value of the product gas was nearly 2000 kcal/m^3, averaging 1935. But for the leakage of air, it wouLd have been 330 kcal higher. The average composition was: CO_2--24.6%, CO--21.9%, H_2--31.6%, CH_4--5.4%, N_2--14.8%, O_2--1.7%. The quantity of product gas per m^3 of oxygen input was 4.49 m^3. 2.49 m^3 of gas were obtained per 1 kg. of coal. The oxygen consumption was 0.72 ton/ton of gasified coal.

55 (UCRL—50026-78-1) **LLL in situ coal gasification program. Quarterly progress report, January—March 1978.** Aiman, W.R.; Fisher, W.T. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 May 1978. Contract W-7405-ENG-48. 48p. Dep. NTIS, PC A03/MF A01.

The gasification phase of the Hoe Creek Experiment No. 2 took 100 days for air-flow testing, reverse-combustion linking, forward-combustion gasification, and post-burn steam flow. Air was used for gasification except for a 2-day test with oxygen and steam. A total of 232 Mmol (194 Mscf) of gas was produced with heating value above 125 kJ/mol (140 Btu/scf) for significant time periods and an average of 96 kJ/mol (108 Btu/scf). During the oxygen-steam test the heating value was twice above 270 kJ/mol (300 Btu/scf) and averaged 235 kJ/mol (265 Btu/scf). The high frequency electromagnetic (HFEM) instrumentation and traveling thermocouple apparatus were both of significant help in conducting the experiment and in evaluating the results. The HFEM was able to locate burn zones in the coal seam with surprisingly fine spatial precision. The apparent precision was about 1m. The traveling thermocouple provided reasonably good temperature profiles in the coal seam at a time in the experiment when the fixed thermocouples were not functioning. The environmental impact experiments are continuing. The development work on shaped-charge devices as an alternate linking technique has resulted in a 20% improvement in the penetration distance of conventional designs. Preliminary plans were made for the Hoe Creek Experiment No. 3. This experiment will be an oxygen-steam gasification using the linked vertical wells (LVW) method with the link provided by directional drilling.

56 (UCRL—80921) **Hoe Creek No. 2: underground coal gasification experiment with air and oxygen/steam injection periods.** Thorsness, C.B.; Cena, R.J.; Aiman, W.R.; Hill, R.W.; Stephens, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Jun 1978. Contract W-7405-ENG-48. 18p. (CONF-781003—4). Dep. NTIS, PC A02/MF A01.

From 53. technical conference and exhibition; Houston, TX, USA (1 Oct 1978).

This paper presents results from the Lawrence Livermore Laboratory Hoe Creek No. 2 underground coal-gasification experiment. The experiment used an injection well and a production well 18.7 m apart and alternating periods of air and oxygen/steam injection. Both low- and medium-heating-value gas was produced. Fourteen days of reverse combustion linked the injection and production wells and was followed by 58 days of forward-combustion gasification. The first five days of gasification produced good-quality gas, with the higher heating value averaging 125 kJ/mol (140 Btu/scf). After this period, the burn was along the top of the coal seam, which sharply lowered the gas quality. The high burn probably resulted from the injection-well casing being broken or burned off at the top of the coal seam. Switching injection to the bottom of the seam resulted in good-quality gas until the end of the experiment. Forward gasification consumed 1310 m^3 (1952 tons) of coal. Air injection produced gas that averaged 94 kJ/mol (105 Btu/scf), and a two-day oxygen/steam burn produced gas of medium heating value: 225 to 270 kJ/mol (250 to 300 Btu/scf), with no operational or safety problems. The same geometry that produced poor-quality gas with air produced good-quality gas with oxygen/steam.

57 **Process for the gasification of coal in situ.** Garrett, D.E. (to Occidental Petroleum Corp.). US Patent 4,087,130. 2 May 1978. Filed date 14 Apr 1977. 12p.

Process for the gasification of coal in situ comprising driving shafts or tunnels into a coal seam, injecting air into the bore holes to ignite and burn the coal to raise its temperature ceasing the flow of air when the coal is hot enough to support the endothermic water gas reaction, and injecting steam into the hot coal formation, such steam preferably being preheated by the flue gases taken from the same end of the bore holes where the air was injected, and recovering product gases, including carbon monoxide and hydrogen, and also product oil, exiting the tunnel at the other end of the bore holes. When the temperature of the coal drops during injection of steam to a level which willl just permit combustion, the steam flow is stopped, and the cycle is repeated by air injection and the flue gas removal at the front end of the bore holes, and through the tunnel connected therewith. This cyclic process is repeated until the entire mass of coal within the area encompassed by the bore holes is exhausted.

58 **Development of in situ processes for energy and fuels from coals.** Wieber, P.R.; Sikri, A.P. (Dep of Energy, Underground Coal Convers Branch, Washington, DC). *Min. Eng. (N.Y.);* **30**: No. 5, 557-565(May 1978).

This article describes the U.S. Energy Research and Development Administration's (ERDA) program to develop in situ coal conversion processes, especially gasification. The potential of this technology, the technical directions being explored, and the program strategy to carry the process concepts toward commercialization are emphasized. The geographic location of the U.S. coal resources and a market analysis are described. Commercially successful in situ coal processes could add over a trillion tons of coal to the U.S. coal reserves. The economics of these processes is compared with surface gasification. Unique factors of the process development are discussed which may lead to commercial processes in the near term. 18 refs.

59 **Process for the gasification of coal.** Steiner, P. (to Foster Wheeler Energy Corp.). US Patent 4,082,519. 4 Apr 1978. Filed date 29 Jun 1976. 4p.

Continuous process for the gasification of particulate coal with steam wherein SO_2 is present, preferably through introduction into the steam, thereby enabling the steam to react with the coal at considerably lower than conventional temperatures such as temperatures ranging upwards of 1200°F, preferably 1400°F.

60 **Effect of alkali metal catalysts on gasification of coal char.** Veraa, M.J.; Bell, A.T. (Univ of Calif, Lawrence Berkeley Lab). *Fuel;* **57**: No. 4, 194-200(Apr 1978).

A detailed study has been conducted of the effects of LiCl, NaCl, KCl, RbCl, CsCl, KOH, and K_2CO_3 on the steam gasification of char produced from a western sub-bituminous coal. Initial screening of results revealed that K_2CO_3 had the greatest catalytic activity for a fixed cation content in the char. Subsequent experiments were performed to determine the effects of K_2CO_3 loading and gasification temperature on the rate of gasification and the product-gas composition. The results show that gasification rate is enhanced with increasing K_2CO_3 loading and reaction temperature. 15 refs.

61 **Chemistry, thermodynamics and kinetics of reactions of sulphur in coal-gas reactions: a review.** Attar, A. (Univ of Houston. Tex). *Fuel;* **57**: No. 4, 201-212(Apr 1978).

An overview of the fundamental reactions of the sulphur-containing groups in coal during pyrolysis and gasification is presented. The available experimental data on the redistribution of the sulphur (ROS) among the gaseous, liquid, and solid products of the reactions are discussed. Then, an attempt is made to draw general conclusions with regard to the effect, of the variables of the reaction systems, on the sulphur content of the products of the reactions. 127 refs.

62 **Pyrolysis of subbituminous coal in relation to in-situ coal gasification.** Campbell, J.H. (Univ of Calif, Lawrence Livermore Lab). *Fuel;* **57**: No. 4, 217-224(Apr 1978).

Several laboratories in the USA are currently developing in-situ coal gasification as a potential new energy source. Much of this work is concentrated on gasification of sub-bituminous Western coals. Pyrolysis of Roland Seam (Wyodak) subbituminous coal has been investigated from 383 to 1273 K in an inert gas at 0.1 MPa (1 bar). The gas, liquid (condensibles at 0°C) and solid products were analyzed and characterized. Evolution of the major noncondensible gas products was measured quantitatively. The effect of temperature on the structure of char was determined by analyzing changes in elemental composition, surface area, and electrical conductivity. 31 refs.

63 **New method of feeding coal: continuous extrusion of fully plastic coal.** Ryason, P.R.; England, C. (JPL, Calif Inst of Technol, Pasadena). *Fuel;* **57**: No. 4, 241-244(Apr 1978).

The problems encountered in feeding the coal into vessels at elevated pressures are reviewed. Continuous feeding of coal in a compressing screw extruder is described as a method of introducing coal into pressurized systems. The method utilizes the property of many bituminous coals of softening at temperatures from 350 to 400°C. Coal is then fed much in the manner of common thermoplastics, using screw extruders. Preliminary results show that coals can be extruded at rates of about 3.3 kg/MJ, similar to those for plastics. 15 refs.

64 **Particle separation from a fluidized mixture. Simulation of the Westinghouse coal gasificatioan combustor/gasifier operation.** Chen, J.L.P.; Keairns, D.L. (Westinghouse Res Lab, Pittsburgh, Pa). *Ind. Eng. Chem., Process Des. Dev.;* **17**: No. 2, 135-141(Apr 1978).

Particle separation data from a 101.6-mm pressurized (up to 660 kPa) model operating at low gas velocity, near the U/sub mf/ of the mixture, and from a 114-mm Plexiglas model operating at high gas velocity, near the U/sub t/ of the mixture, with a nozzle located at the center of a conical bottom, are presented. These models were used to simulate the design and operation of alternative fluidized-bed

agglomerating combustor/gasifier concepts. Comparison of the data obtained from these two modes of operation is made and a design for the separation of the agglomerated ash at low gas velocity is established. The data indicate that >95% separation of the agglomerated ash from char at a rate of about 400 kg/min m^2 of the separator cross-sectional area can be achieved if the operating gas velocity is close to the minimum fluidizing velocity, e.g., 1.0 to 1.5 times U/sub mf/, of the agglomerated ash. 10 refs.

65 Gas generator. Feistel, P.P.; Van Heek, K.H.; Juentgen, H.; Duerrfeld, R. (to Bergwerksverband GmbH). US Patent 4,080,181. 21 Mar 1978. Priority date 6 Nov 1975, German, Federal Republic of (F.R. Germany). 8p.

A gas generator is provided for the production of gas from fuel and steam under conditions of high pressure and temperature. The requisite temperature is preferably provided by a nuclear reactor. The gas generator includes a cylinder with a hollow interior. Extending transversely through the hollow interior of the cylinder is a container. Tubular heat exchangers are vertically arranged over the length, width and height of the cylinder in such a manner that the density of heating surfaces decreases along the length of the container.

66 Coal conversion process. Leas, A.M. (to Leas Brothers Development Corp.). US Patent 4,078,989. 14 Mar 1978. Filed date 11 May 1976. 8p.

In accordance with the present invention, a process for the conversion of carbonaceous materials to clean liquid and gaseous fuels is provided which comprises reacting an active metal catalyst, recycle fuel gas and carbonaceous material in a U-Bend mixer; separating fuel values therefrom in a gas separator; feeding unreacted or undissolved carbonaceous material and metal catalyst with hot recirculating siliceous particles to a carbonaceous material reactor at temperatures sufficiently high to remove additional fuel values from said carbonaceous material, recovering resultant ash admixed with spent metal catalyst therefrom, separating metal catalyst therefrom and recovering as metal carbonyl by reaction with carbon monoxide, converting said metal carbonyl to metal sulfide and recycling to said mixture.

67 Coal gasification. Eales, D.F. (to British Gas Corp.). US Patent 4,078,903. 14 Mar 1978. Priority date 27 Nov 1975, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

In a slagging gasifier the slag quenching chamber is provided with means having a plurality of equispaced outlet ports disposed around the inside of the upper region of the chamber, each outlet port communicating with a venting control which may be used selectively to vent the normally pressurized quenching chamber to atmosphere during a slag-tapping operation.

68 Underground coal gasification tests monitored by minicomputer system. Hale, D. *Pipeline Gas J.;* **205**: No. 3, 58, 60, 62, 67(Mar 1978).

Minicomputers helping to control underground fires 300 ft beneath the sage-covered country near Hanna, Wyoming, are assisting energy resource scientists in finding ways to tap an almost limitless domestic fuel source--coal. Underground coal gasification may prove to be a significant factor in narrowing America's energy gap. A Hewlett-Packard 9600 series data acquisition and measurement system containing an HP 21 MX processor as well as an HP signal conditioning sub-system is being used to monitor some 200 sensors, including thermocouples placed in input, output, and special instrument wells. Pressure, flow, wind, and geological characteristics, and gas chromatography analyses of output product gas, are also recorded and processed by the minicomputer system in real time. The results are then used by Energy Research and Development Administration researchers of the Laramie Energy Research Center (LERC) to alter ongoing experimental conditions.

69 European prospects for deep underground coal gasification. Ledent, P. (Inst Natl des Ind Extr, Liege-Belg). *Ind. Miner. (St.-Etienne, Fr.);* **60**: No. 3, 145-158(Mar 1978). (In French).

After briefly discussing the importance of coal in Europe's energy supply, the author analyzes performance and characteristics of in-situ coal gasification at both smaller and greater depths. He concludes that the deep underground gasification holds better promise because it eliminates gas leaks and inrush of water, and offers the possibility of operating at high pressure and using air, oxygen and hydrogen. Some technical problems associated with the in-situ gasification of coal at great depth are also covered. 9 refs.

70 Process for quenching product gas of slagging coal gasifier. Staudinger, G.; van der Burgt, M.J. (to Shell Internationale Research Maatschappij B.V.). US Patent 4,054,424. 18 Oct 1977. Priority date 17 Jun 1974, Netherlands. 8p.

A process is disclosed for quenching of the partial combustion product gas of a slagging coal gasifier containing suspended molten slag particles, wherein the hot product gas of the gasifier is passed through a tubular quench zone into which a shielding gas is introduced circumferentially to form an annular layer or protective gas shield between the product gas and the walls of the quench zone and a cooling gas is injected radially to effect direct cooling of the product gas to a temperature at which the molten slag particles solidify and lose their stickiness, said protective gas shield being maintained for a sufficient distance along the axis of the quench zone walls to prevent contact between the quench zone walls and the hot product gas during said cooling.

LIQUEFACTION

REFER ALSO TO CITATION(S) 10, 16, 17, 21, 30, 31, 32, 39, 45, 51, 66, 106, 107, 831, 983

71 (CONF-780732—3) **Role of metallography in the failure analyses in coal conversion systems.** King, R.T. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

From Metallographic Society Technical conference; Montreal, Canada (16 Jul 1978).

Failure analysis and prevention activities seek to increase the technological benefits from process demonstration and pilot plants for coal conversion. Metallographic methods combined with chemical analysis, reviews of operating histories, and other tools have played a major role in resolving the causes of failures and gathering surveillance data to prevent failures. Two analyses performed for coal liquefaction plants illustrate the breadth of problems encountered in one area of complex pilot plant operations. Examinations of portions of the piping systems, the main reaction vessel, and associated fittings revealed stress-corrosion cracking of austenitic stainless steels, albeit under unknown stresses and chemical environments. A solid plug formed from process stream material was caused by coking; its microstructure provided clues to its origin. A range of metallographic methods, including field metallography, was required to complete the investigations of materials from the reaction vessel area of the plants. A buckled and cracked, punched type 310 stainless steel plate that was used as an air distributor for an atmospheric fluidized-bed combustor required electron optics and diffraction methods. Low-ductility intergranular failures suggested that a massive grain boundary precipitate was sigma phase that had formed during service above 650°C. Neither conventional color etching phase identification techniques nor anodic extraction methods to prepare samples for diffraction analyses were successful. Examination of thinned samples by transmission electron microscopy and electron diffraction were required to identify the precipitate as sigma phase. The general scope and methodology of failure analysis work are also discussed.

72 (DOE/ET—0026/1) **Coal liquefaction. Quarterly report, January—March 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion; Cameron Engineers, Inc., Denver, CO (USA)). Dec 1977. Contract EX-76-C-01-2297. 68p. Dep. NTIS, PC A04/MF A01.

Current ERDA work in coal liquefaction is aimed at improved process configurations for both catalytic and non-catalytic processes to provide more attractive processing economics and lower capital investment. Coal liquefaction can now be achieved under more moderate processing conditions and more rapidly than was the case in the 1930's. The advantage of coal liquefaction is that the entire range of liquid products, including heavy boiler fuel, distillate fuel oil, gasoline, jet fuel, and diesel oil, can be produced from coal by varying the type of process and operating conditions used in the process. Furthermore, coal-derived liquid fuels also have the potential for use as chemical feedstocks. To determine the most efficient means of utilizing coal resources, ERDA is sponsoring the development of several conversion processes that are currently in the pilot plant stage. Nineteen projects under development are described and progress for each in the quarter is detailed briefly. (LTN)

73 (DOE/ET—0026/3) **Coal liquefaction. Quarterly report, July—September 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion; Cameron Engineers, Inc., Denver, CO (USA)). Feb 1978. Contract EX-76-C-01-2297. 74p. Dep. NTIS, PC A04/MF A01.

ERDA's program for the conversion of coal to liquid fuels is aimed at improved process configurations for both catalytic and noncatalytic processes to provide more attractive processing economics and lower capital investment. The advantage of coal liquefaction is that the entire range of liquid products, including heavy boiler fuel, distillate fuel oil, gasoline, jet fuel, and diesel oil, can be produced from coal by varying the type of process and operating conditions used in the process. Furthermore, coal-derived liquids also have the potential for use as chemical feedstocks. To provide efficient and practical means of utilizing coal resources, ERDA is sponsoring the development of several conversion processes that are

currently in the pilot plant stage. Responsibility for the design, construction, and operation of these facilities is given and progress in the quarter is summarized. Several supporting or complementary projects are described similarly. (LTN)

74 (EPRI-AF—777) **Gasification of coal liquefaction residues from the Wilsonville SRC pilot plant using the Texaco Coal Gasification Process. Final report.** Robin, A.M. (Texaco, Inc., South El Monte, CA (USA). Montebello Research Lab.). Jun 1978. 78p. Dep. NTIS, PC A05/MF A01.

High ash containing residues from the liquefaction of Kentucky 9/14 coal using the SRC-I process were successfully gasified in a pilot plant Texaco Coal Gasifier at 24 atmospheres pressure. Four sets of runs were completed using filter cake, high ash SRC and Kentucky coal in various mixtures. The first set consisted of three short exploratory runs charging a slurry of filter cake and water. Essentially complete conversion of carbon in the filter cake to syngas was achieved. The second set consisted of seven runs charging molten high ash SRC to the gasifier. A variety of conditions were investigated. Conversion of carbon in the feed to syngas varied from 97 to 100%. The third set consisted of three short runs charging a slurry of ground Kentucky 9/14 coal, high ash SRC and aromatic solvent. A 98% conversion of carbon in the feed to syngas was achieved. The fourth and final set consisted of two short exploratory runs charging a slurry of filter cake, high ash SRC and aromatic solvent. Better than 98% of the carbon in the feed was converted to syngas.

75 (FE—1800-24) **Research and development of an advanced process for conversion of coal to synthetic gasoline and other distillate motor fuels. Quarterly report, December 1977—February 1978.** Sinnett, C.E.; Wynne, F.E. (Gulf Research and Development Co., Pittsburgh, PA (USA)). May 1978. Contract EX-76-C-01-1800. 31p. Dep. NTIS, PC A03/MF A01.

Delayed coking of a slurry of bituminous or subbituminous coal with vacuum bottoms and cycle oil in an existing domestic oil refinery would reduce profits assuming an ample supply of crude oil and using projected prices for coal and refined products. A high manufacturing expense is incurred which is a result, to a large extent, of the high catalyst make-up requirements when catalytic cracking feedstock containing diverted high-metals content vacuum bottoms. A profitable coal slurry coking process could be obtained under circumstances in which a high-sulfur (about 4 percent) fuel oil could be marketed, excess FCC and alkylation unit capacities are available due to feedstock shortages, and in which an improved metals-tolerant FCC catalyst (or a low-metals FCC feedstock) is available. These conclusions are believed to be applicable also to a crude oil shortage situation. In summary, these economics, based on actual experimental results, are not surprising and confirm the original assumptions which led to this project.

76 (FE—2034-11) **Catalytic hydrogenation of coal-derived liquids. Interim report for the period, March 1978 through May 1978.** Berg, L.; McCandless, F.P. (Montana State Univ., Bozeman (USA)). Jul 1978. Contract EX-76-C-01-2034. 90p. Dep. NTIS, MF A01.

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The investigation of the catalytic hydrotreating of COED pyrolysis oil was completed. The investigation of commercially available catalysts showed that nickel molybdates are best for nitrogen removal, cobalt molybdates best for sulfur removal. Fabrication of catalysts specifically for use in hydrotreating COED pyrolysis oil showed that cobalt-nickel-molybdates on alumina and/or alumina silicates of large pore diameter are the most promising. This report contains a complete description of the work done on COED pyrolysis oil during the entire life of this contract. Work continued on PAMCO's SRC-II solvent refined coal. A summary of all the work done with SRC during the life of this contract will appear in the next quarterly report, FE-2034-12. With SYNTHOIL, three additional commercially available catalysts were investigated; two were cobalt molybdates, the other was a nickel molybdate. Three cobalt-nickel-molybdates fabricated at MSU were also investigated. Rapidly declining activity of these catalysts made it difficult to compare them accurately with previously reported work but a cobalt-nickel-molybdate on an alumina carrier of large pore diameter looks promising for nitrogen and sulfur removal as well as conversion to lower boiling products.

77 (FE—2307-29) **Research and development of rapid hydrogenation for coal conversion to synthetic motor fuels (riser cracking of coal). Project 8976 task report: Task 3. Design of a process development unit.** Duncan, D.A.; Beeson, J.L.; Oberle, R.D. (Institute of Gas Technology, Chicago, IL (USA)). May 1978. Contract EX-76-C-01-2307. 27p. Dep. NTIS, PC A03/MF A01.

This report presents a detailed design of a process development unit (PDU) for the riser cracking of coal to produce fuel gases, high-octane motor gasoline blending stock, and fuel oil. At the maximum design capacity, 100 lb/hr of feed coal and 12 lb/hr of hydrogen can be processed. The riser reactor is not equipped with external heaters; the heat needed to accomplish the hydropyrolysis will be generated by the combustion of small quantities of oxygen or air injected into the riser reactor. Because of the "balanced pressure" design, operating temperatures as high as 1800°F at 2000 psig can be readily obtained, allowing the PDU to be operated in an SNG production mode, as well as the lower temperature pyrolysis for the production of liquid fuels.

78 (FE—2353-20(Vol.2)) **EDS coal liquefaction process development: Phase IIIA. Final technical progress report, January 1, 1976—June 30, 1977.** Fant, B.T. (Exxon Research and Engineering Co., Baytown, TX (USA). Baytown Research and Development Div.). Feb 1978. Contract EX-76-C-01-2353. 459p. Dep. NTIS (US Sales Only), PC A20/MF A01.

The Final Technical Progress Report for ERDA Contract No. E(49-18)-2353 for the EDS (Exxon Donor Solvent) Coal Liquefaction Process Development—Phase IIIA", is presented in two volumes. Volume I contains the Laboratory Process Research and Development contribution and includes Technical Reporting Categories 1 to 7 and the Appendices for these sections. Volume II contains the Engineering Research and Development contribution and includes Technical Reporting Categories 8 to 11 (Commercial Study Design and Cost Estimate, Cost Reduction and Laboratory Guidance Studies, Pyrolysis and Gasification Engineering Studies, and Engineering Technology Studies). (LTN)

79 (FE—2454-3) **Studies in coal liquefaction with application to the SRC and related processes. Quarterly report, January—March 1977.** Guin, J.A.; Tarrer, A.R. (Auburn Univ., AL (USA). Coal Conversion Lab.). 1977. Contract EX-76-S-01-2454. 99p. Dep. NTIS, PC A05/MF A01.

This report describes work performed in a program designed to further understand and improve the Solvent Refined Coal and related liquefaction processes. Considerable progress was made as four papers were finished for presentation at the Chicago meeting of the ACS Fuel Chemistry Division in August, 1977. These papers give the results of a Coulter Counter particle size analysis method for the SRC process, the effects of mineral matter on the hydrogenation/desulfurization reactions in the SRC process, a comprehensive model for the continuous SRC reactor/dissolver, and an X-ray fluorescence technique for SRC analysis. Other results include a detailed study of the effect of initial particle size of four coals used in the SRC process, an evaluation of additional coals in the visual reactor for SRC processability, experimental data showing the viscosity peaks present in the SRC preheater/dissolver and solubility of CO_2 and CH_4 in SRC recycle solvent.

80 (FE—2454-3, pp 59-69) **Selectivity of coal minerals as catalysts in coal liquefaction and hydrodesulfurization.** Lee, J.M.; Tarrer, A.R.; Guin, J.A.; Prather, J.W. (Auburn Univ., AL). 1977.

In Studies in coal liquefaction with application to the SRC and related processes. Quarterly report, January—March 1977.

To better understand the importance of coal mineral catalysis in the SRC process, this work presents comparative results of the rates of hydrogenation and hydrodesulfurization of coal/oil slurries under different reaction conditions and in the presence of different coal minerals. The selectivity of coal minerals such as reduced iron and SRC residue (Wilsonville SRC pilot plant) for hydrodesulfurization as opposed to hydrogenation has been determined based on product distribution (oil, asphaltene and preasphaltene), sulfur content of each product and analyses of liquid products. The rate limiting steps, or the reaction step most affected by catalytic activity of coal minerals have also been examined. In contrast to the minerals indigenous to coal, Fe has been shown here to be most attractive as a catalyst for the SRC process: (1) it is an effective HDS catalyst; (2) it is somewhat selective with regard to accelerating hydrogenation reactions, with minimal contribution to increased hydrogen consumption.

81 (FE—2454-3, pp 70-81) **Dispersion model for the Solvent Refined Coal Process.** Lee, M.H. Jr.; Guin, J.A.; Tarrer, A.R. (Auburn Univ., AL). 1977.

In Studies in coal liquefaction with application to the SRC and related processes. Quarterly report, January—March 1977.

In this paper an axial dispersion model for two-phase flow is applied to study the kinetics of hydrogenation, desulfurization, and coal conversion in the SRC process: 1. The mixing and flow pattern of the multi-phase reactor is taken into account through the axial dispersion term, not previously utilized for SRC reactor modeling. 2. The mass transfer of hydrogen from the gas phase into the liquid phase is also accounted for in the model, the effect of hydrogen mass transfer rate on the hydrogen consumption and coal dissolution rate can be easily simulated; and the influence and extent of mass transfer control can be assessed. In particular, the Wilsonville SRC reactor is found to operate in a kinetically, rather than a mass transfer, limited regime. 3. All of the parameters in the model are obtainable independently from literature correlation; these parameters have definite physical meanings based upon the flow conditions; therefore, by

changing the relative magnitude of each parameter, the general trend of the effect of each operating variable on the SRC process can be assessed, thus providing a better engineering design basis for simulation and optimization of the SRC process. 4. The hydrogen consumption and organic sulfur removal at the Wilsonville SRC pilot plant are higher than predicted by the present model, which uses kinetics rate expressions from laboratory experiments. This is probably due to the accumulation of catalytic coal minerals in the Wilsonville reactor, giving higher rate constants.

82 (FE—2454-3, pp 82-87) **X-ray fluorescence analysis of trace metals in solvent refined coal.** Prather, J.W.; Tarrer, A.R.; Guin, J.A. (Auburn Univ., AL). 1977.

In Studies in coal liquefaction with application to the SRC and related processes. Quarterly report, January—March 1977.

This work was undertaken to ascertain the ability of Energy Dispersive X-ray Fluorescence (EDXRF) analysis to determine trace element content of Solvent Refined Coal (SRC). As a result of recent improvements in the design of solid state detectors for X-ray Fluoresence, it is now possible to do very rapid simultaneous quantitative analysis of a large number of elements. In this work some 17 elements are quantitatively analyzed in both raw feed coal and product SRC from the Wilsonville SRC Pilot Plant, Wilsonville, Alabama. The content of trace metals in SRC product and in feed coal is important for several reasons: Certain metals, particularly iron, catalyze the hydrogenation and hydrodesulfurization reactions that occur in the SRC process. If the SRC product is to be used to fire a gas turbine, then trace metals such as Ca, Na, and V present potential corrosion or fouling problems. Trace metals such as As in SRC product present potential environmental problems. Also, metals such as Fe and Al are present in sufficient quantity in the feed coal that the SRC mineral residue represents an attractive source of these metals when current sources have been depleted. It has been shown that EDXRF is capable of analyzing coals and SRC's for elemental content. These analyses provide simultaneous results for several important elements, namely sulfur, iron and calcium, as well as percent ash. These analyses presently take well over 2 hours per sample to complete, but by using EDXRF this time can be reduced to less than one hour per sample. Furthermore, EDXRF may be automated, leading to even shorter analysis times per sample. Thus, EDXRF can be concluded to be an effective tool that can provide very accurate and rapid analyses of coals and SRC product for their elemental content.

83 (FE—2454-3, pp 88-95) **Particle size analysis in the SRC process by Coulter Counter.** Curtis, C.W.; Tarrer, A.R.; Guin, J.A. (Auburn Univ., AL). 1977.

In Studies in coal liquefaction with application to the SRC and related processes. Quarterly report, January—March 1977.

This work was undertaken to develop an effective rapid technique for determining particle size of undissolved solids in the Solvent Refined Coal (SRC) Process. Particle size distributions for SRC filter feed from the Wilsonville SRC Pilot Plant and autoclave reaction mixtures from the Auburn Coal Conversion Laboratory were measured using a Coulter Counter Model TA. The Coulter principle was originally applied to blood cell counting and is now widely used in the biomedical area for cell counting and size distribution. Industrial use of the Coulter technique is now widespread. The Coulter technique has been applied in the size analysis of pulverized coal, coal dust, and fly-ash. Presently, the Coulter technique is being applied to the study of particle size distributions in the SRC process. Interest in the effect of the mean particle size in the effluent from the SRC dissolver on filtration along with the problem of dissolver solids accumulation has shown the need for a reproducible method of determining particle size in SRC process streams.

84 (FE—2468-25) **Comparison of coal liquefaction processes. Final report on Task 006.** Rogers, K.A.; Wilk, A.S.; McBeath, B.C.; Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Apr 1978. Contract EF-77-C-01-2468. 26p. Dep. NTIS, PC A03/MF A01.

Five processes were studied to determine which could give best results for supplying hydrocarbon fuels to replace petroleum products. The processes were Fischer-Tropsch; M-Gasoline; H-Coal; Exxon Donor Solvent; and Solvent Refined Coal. The conclusions of the study are that all of the processes are considered commercially feasible and, because the different products from the different processes will meet different market demands, any significant future liquids from coal market will probably use some of each of these processes. The anticipated conversion efficiency values are given to indicate resource utilization. Simplified capital costs are approximated for each process. These are used in combination with product amounts and relative values to achieve a cost ranking. Because the study was concerned solely with liquid products, Fischer-Tropsch was at a disadvantage. The remaining four were relatively close and a final decision would depend upon the actual end use requirements. For a situation with residual fuels selling at severe discounts, M-Gasoline and H-Coal (Syncrude Mode) were the better choices.

85 (FE—2550-4) **Physical and chemical behavior of liquefied coal in solids separation. Annual report for the year ending September 30, 1977.** Briggs, D.E.; Addington, D.V.; Berry, C.E. Jr. (Michigan Univ., Ann Arbor (USA)). Oct 1977. Contract EX-76-S-01-2550. 139p. Dep. NTIS, PC A07/MF A01.

Four bis-(hydroxyphenyl)alkanes and four α,ω-dipyridyl or diquinolyl-alkanes were synthesized, purified, and examined by proton NMR. The compounds are believed to possess characteristics of asphaltenes. Solvent-extracted asphaltenes from an H-coal liquefaction of an Illinois No. 6 Coal were fractioned and characterized by molecular weight, elemental and proton NMR analyses. Oxygen and metals levels were determined by neutron activation. Filtration data were taken at 232°C (450°F) at different concentrations of oils, resins, asphaltenes, and preasphaltenes with 13.8 wt % THF insoluble solids. Electrophoresis experiments with asphaltene and preasphaltene fractions gave deposition on both electrodes, being largest on the positive electrode with pyridine, THF, and m-cresol and on the negative electrode with benzene and tetralin as solvents. Adsorption characteristics of GPC fractionated asphaltenes were examined. The analysis included the effects of concentration, temperature, solvent and solid adsorbent. Micelle formation was apparent with the higher molecular weight asphaltene fractions. Adsorption experiments on two and three ring aromatic compounds were conducted to assess the adsorption tendency of various functional groups. Streaming potential measurements were made for the flow of asphaltene solutions through fixed beds of solids to assess the effects of concentration, temperature, solvent, and solid adsorbent. There is consistency in the electrophoresis, adsorption and streaming potential data.

86 (FE—2550-5) **Physical and chemical behavior of liquefied coal in solids separation. Quarterly report, October—December 1977.** Briggs, D.E.; Addington, D.V.; Cameron, J.R. (Michigan Univ., Ann Arbor (USA)). Jan 1978. Contract EX-76-S-01-2550. 49p. Dep. NTIS, PC A03/MF A01.

Work on the synthesis and proton NMR analysis of representative groups of bis-phenols, tris-phenols and tetrakis-phenols was essentially completed. A bis-pyridyl compound was synthesized. A study on the oxidative degradation of asphaltene was begun. The cake compressibility of THF-insoluble residue from H-Coal vacuum bottoms at 232°C (450°F) was 0.75 compared to a value of 0.36 at 176.7°C (350°F). The increase in compressibility results from softening of residual organic matter. The solubility of asphaltenes in THF alone and in combination with decalin, pentane and tetralin was measured. The asphaltene adsorption characteristics of the filter media effects the amount of precipitate collected. Under scanning electron microscope examination the precipitate appears as clusters of 0.2-0.5 μm particles. Asphaltenes were separated by perchloric acid treatment into basic and acidic-neutral fractions. Equilibrium adsorption isotherms of the fractions in tetralin, pyridine, and m-cresol measured with an alumina adsorbent were surprisingly similar. The effect of temperature, asphaltene concentration, solvent and liquefied coal fraction on the zeta-potential in the presence of THF-insoluble coal liquefaction residue was measured.

87 (PNL—2608) **Solvent refined coal studies: effects and characterization of treated solvent refined coal effluent. Progress report, FY 1977.** Becker, C.D.; Woodfield, W.G.; Strand, J.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1978. Contract EY-76-C-06-1830. 38p. Dep. NTIS, PC A03/MF A01.

The Freshwater Sciences Section of PNL has initiated biologically oriented studies at the P and M solvent refined coal (SRC) pilot plant on the Fort Lewis Reservation in western Washington. Essentially, the study objectives are to identify residual components in the treated SRC process and assess potential for adverse impact on water quality and aquatic biota. Since inception of research in mid-1976, six static toxicity tests with treated SRC process effluent have been conducted. Toxic components, not yet specifically identified, sometimes occur in the effluent. It is believed these components involve organic hydrocarbons of the phenol and cresol groups. Analyses have been obtained on inorganic and organic constituents in partially-treated and treated process effluent. Concentrations of inorganics identified in the effluent did not differ greatly from their concentrations in Lake Sequalitchew or SRC plant tap water, but the low concentrations may be due primarily to dilution with freshwater before discharge. Organics identified in the effluent are similar to those found in samples contaminated with petroleum, and involve many complex hydrocarbons.

88 (SAND—78-1113) **Chemical studies on the Synthoil process: mineral matter effects. Final report, September 1, 1975—September 30, 1977.** Granoff, B.; Baca, P.M.; Thomas, M.G.; Noles, G.T. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 124p. Dep. NTIS, PC A06/MF A01.

Mineral matter effects in coal liquefaction were studied by means of batch autoclave experiments at temperatures of 395 to 430°C, residence times (at temperature) of 15 to 60 min and operating pressures of 1500 to 3000 psig. All experiments were carried out in creosote oil (No. 4 cut) as the solvent. High volatile bituminous coals from Kentucky, Indiana, West Virginia, Illinois and Pennsylvania were used for most of this work. The mineral contents of these coals, as determined by low temperature ashing, ranged from 24.6 to 5.2 percent; the corresponding sulfur contents ranged from 6.7 to 0.8 percent. A series of screening experiments was carried out at 430°C, with six coals whose petrographic composition was similar (reactive maceral contents ranged from 85 to 95 percent), but whose mineral content varied from 5.2 to 20.9 percent. It was found that as the mineral content increased, the conversion of coal to benzene solubles increased from 22.4 to 73.5 percent, the viscosity of the liquid products decreased from 761 to 75 cp (at 60°C), hydrogen consumption increased from 1.8 to 3.4 percent and hydrocarbon gas formation (C_1—C_4) remained fairly constant between 2.0 and 2.5 percent. Runs were carried out at 405°C with Kentucky No. 11 demineralized by gravity separation and with the heavy concentrate showed that as the mineral content increased the conversion to benzene solubles increased from 37.2 to 63.3 percent, the viscosity of the liquid products decreased from 765 to 41 cp (at 60°C), hydrogen consumption increased from 1 to 3 percent, preasphaltene content decreased from 15.4 to 5.5 percent and pentane-soluble oil yield increased from 63.1 to 73.8 percent. The specific effects of several minerals (pyrite, pyrrhotite, kaolinite, montmorillonite, etc.) and of a commercial Co/Mo hydrodesulfurization catalyst (Harshaw 0402 T) were studied in a number of autoclave runs at 405°C with Illinois No. 6 coal.

89 (SAND—78-1235) **Chemical studies for SYNTHOIL Processes heater studies.** Traeger, R.K.; Curlee, R.M. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 53p. Dep. NTIS, PC A04/MF A01.

Non-catalytic liquefaction of West Virginia (Ireland Mine) coal in creosote oil was studied in a four stage, packed continuous reactor. Reactor conditions included 425°C, 4000 psi, liquid space velocities of 140 to 1600 lbs/h-ft^3 and gas rates of 260 to 2800 MSCF/ton of coal to bracket conditions used in the SYNTHOIL preheater. Gas flow rates had no significant effect on the coal liquefaction processes. Preasphaltene content and the viscosity of the coal liquid increased rapidly early in the reactor; feed of this high preasphaltene product into a subsequent catalytic reactor could lead to plugging and coking. Approximately 50 percent of the sulfur was removed rapidly and little additional removal occurred at low liquid space velocities. Over 90 percent of the organic matter in the coal was converted to THF soluble products and over 70 percent to benzene soluble products at liquid space rates below 150 lbs/h-ft^3. At these low rates, the hydrogen/carbon ratio of the product and gas formation also increased. The data shows qualitatively the reactions occurring in preheaters for coal liquefaction plants; specifically the packed preheater for the SYNTHOIL Process. Residence time data needs to be obtained to provide quantitative engineering design data.

90 **Hydrogen donor solvent coal liquefaction process.** Plumlee, K.W. (to Exxon Research and Engineering Co.). US Patent 4,085,033. 18 Apr 1978. Filed date 29 Dec 1976. 8p.

An indigenous hydrocarbon product stream boiling within a range of from about C_1-700°F, preferably C_1-400°F, is treated to produce an upgraded hydrocarbon fuel component and a component which can be recycled, with a suitable donor solvent, to a coal liquefaction zone to catalyze the reaction. In accordance therewith, a liquid hydrocarbon fraction with a high end boiling point range up to about 700°F, preferably up to about 400°F, is separated from a coal liquefaction zone effluent, the separated fraction is contacted with an alkaline medium to provide a hydrocarbon phase and an aqueous extract phase, the aqueous phase is neutralized, and contacted with a peroxygen compound to convert indigenous components of the aqueous phase of the hydrocarbon fraction into catalytic components, such that the aqueous stream is suitable for recycle to the coal liquefaction zone. Naturally occurring phenols and alkyl substituted phenols, found in the aqueous phase, are converted, by the addition of hydroxyl constituents to phenols, to dihydroxy benzenes which, as disclosed in copending Application Ser. Nos. 686,813 now U.S. Pat. No. 4,049,536; 686,814, now U.S. Pat. No. 4,049,537;686,827 now U.S. Pat. No. 4,051,012 and 686,828, K.W. Plumblee et al, filed May 17, 1976, are suitable hydrogen transfer catalysts.

91 **Hydrogen donor solvent coal liquefaction process.** Aczel, T.; Plumlee, K.W. (to Exxon Research and Engineering Co.). US Patent 4,085,032. 18 Apr 1978. Filed date 29 Dec 1976. 8p.

An indigenous aqueous stream can be treated and then recycled, with a suitable donor solvent, to a coal liquefaction zone to catalyze the reaction. In one embodiment, an aqueous fraction is separated from a coal liquefaction zone effluent, a quinone solids portion of the separated fraction is concentrated within the liquid by evaporation of water therefrom to form a slurry, and the slurry is then recycled to the coal liquefaction zone to catalyze the coal liquefaction reaction. Naturally occurring phenols and alkyl substituted phenols, also found within the aqueous stream, can also be converted to quinones, if desired, by a chemical reaction which favors the addition of hydroxyl constitutents to the phenols to form dihydroxy benzenes. Quinones, as disclosed in copending Applications Ser. No. 686,813 now U.S. Pat. No. 4,049,536; Ser. No. 686,814 now U.S. Pat. No. 4,049,537; Ser. No. 686,827 now U.S. Pat. No. 4,051,012 and Ser. No. 686,828, K.W. Plumlee et al, filed May 17, 1976, are suitable hydrogen transfer catalysts.

92 **Coal liquefaction with subsequent bottoms pyrolysis.** Walchuk, G.P. (to Exxon Research and Engineering Co.). US Patent 4,085,031. 18 Apr 1978. Filed date 11 Aug 1976. 14p.

In a coal liquefaction process wherein heavy bottoms produced in a liquefaction zone are upgraded by coking or a similar pyrolysis step, pyrolysis liquids boiling in excess of about 1000°F are further reacted with molecular hydrogen in a reaction zone external of the liquefaction zone, the resulting effluent is fractionated to produce one or more distillate fractions and a bottoms fraction, a portion of this bottoms fraction is recycled to the reaction zone, and the remaining portion of the bottoms fraction is recycled to the pyrolysis step.

93 **Process for the liquefaction of coal and separation of solids from the product stream.** Gatsis, J.G.; Tan, G. (to UOP Inc.). US Patent 4,082,643. 4 Apr 1978. Filed date 14 Dec 1976. 8p.

Production of a low mineral content fuel by a coal liquefaction process utilizing a hydrogenated coal solvent having been hydrogenated to remove at least about 80% of the asphaltenes which yields as the primary product a mixture of liquid and solids, a part of which is suspended in the liquid. The suspended solids are effectively removed with minimum loss of desired product by means of a light aromatic solvent in combination with a hydrogenated coal solvent having been hydrogenated to remove at least about 80% of the asphaltenes.

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95 **Calorimetric study of quinoline interaction with o-phenylphenol and coal-derived asphaltenes.** Tewari, K.C.; Gayla, L.G.; Egan, K.M.; Li, N.C. (Duquesne Univ, Pittsburgh, Pa). *Fuel;* **57**: No. 4, 245-249(Apr 1978).

Experimental results are given about the interaction of quinoline with o-phenylphenol in solvents CCl_4 and CS_2, and with coal-derived asphaltenes in solvent benzene. All experiments were made at 298 K. 14 refs.

96 **Conversion of coal into motor fuel.** Heinemann, H. (to Mobil Oil Corp.). US Patent 4,081,351. 28 Mar 1978. Filed date 2 Sep 1976. 10p.

This invention provides an improved process for deriving motor fuel from coal which involves the steps of solubilizing coal in a liquefaction solvent; separating undissolved solids from the liquefaction solution; fractionating the liquid phase by distillation; subjecting intermediate distillate fractions to denitrification treatment; and catalytic cracking of the resultant denitrified synthetic crude oil to produce premium grade gasoline.

97 **Process for the conversion of carbonaceous materials.** Hildebrand, R.E.; Montagna, A.A.; Paraskos, J.A. (to Gulf Research and Development Co.). US Patent 4,081,361. 28 Mar 1978. Filed date 26 Jul 1976. 12p.

A process is described for converting solid carbonaceous material to a liquid product which involves heating a slurry composed of the solid carbonaceous material and a solvent, together with hydrogen, at elevated temperatures and elevated pressures in the presence of a substantially phosphate-free catalyst comprising a hydrogenating component selected from the group consisting of Group VI and Group VIII metals, their oxides and sulfides, supported on a non-zeolitic carrier, which catalyst is promoted with a minor amount of a Group IV-B metal.

98 **Method for suppressing asphaltene formation during coal liquefaction and separation of solids from the liquid product.** Tan, G.; Gatsis, J.G. (to UOP Inc.). US Patent 4,081,360. 28 Mar 1978. Filed date 29 Dec 1976. 8p.

A method is described for suppressing asphaltene formation during coal liquefaction utilizing a hydrogenated coal solvent having been hydrogenated to remove at least about 80% of the asphaltenes which yields as the primary product a mixture of liquid and solids, a part of which is suspended in the liquid. The solids are effectively removed with a minimum loss of desired product and suppressed asphaltene formation by means of a light aromatic solvent in combination with a hydrogenated coal oil solvent having been hydrogenated to remove at least about 80% of the asphaltenes.

99 Process for the liquefaction of coal and separation of solids from the liquid product. Gatsis, J.G.; Tan, G. (to UOP Inc.). US Patent 4,081,359. 28 Mar 1978. Filed date 14 Dec 1976. 8p.

Production of a low mineral content fuel by a coal liquefaction process utilizing a hydrogenated coal solvent having been hydrogenated to remove at least about 80% of the asphaltenes which yields as the primary product a mixture of liquid and solids, a part of which is suspended in the liquid. The suspended solids are effectively removed with minimum loss of desired product by means of a light aromatic solvent in combination with a hydrogenated coal solvent.

100 Process for the liquefaction of coal and separation of solids from the liquid product. Tan, G.; Gatsis, J.G. (to UOP Inc.). US Patent 4,081,358. 28 Mar 1978. Filed date 29 Dec 1976. 8p.

Production of a low mineral content fuel by a coal liquefaction process utilizing a hydrogenated coal solvent having been hydrogenated to remove at least about 80% of the asphaltenes which yields as the primary product a mixture of liquid and solids, a part of which is suspended in the liquid. The suspended solids are effectively removed with minimum loss of desired product by means of a light aromatic solvent in combination with a hydrogenated coal solvent having been hydrogenated to remove at least about 80% of the asphaltenes with a weight ratio of unreacted coal oil solvent to light aromatic solvent of from about 0.1 to about 1000.

101 Method for separating undissolved solids from a coal liquefaction product. Tan, G.; Gatsis, J.G. (to UOP Inc.). US Patent 4,079,004. 14 Mar 1978. Filed date 14 Dec 1976. 8p.

Production of a low mineral content fuel from a coal liquefaction product utilizing a hydrogenated coal oil solvent and a light aromatic solvent in combination to remove suspended mineral solids.

102 Coal liquefaction at CRE. Gibson, J. *Coal Energy Q.;* No. 16, 6-14(1978).

The probability of coal being used as a commercial source for liquid fuels and chemical feedstocks was brought nearer to reality by the announcement last February of collaboration between the NCB (National Coal Board) and British Petroleum in studies aimed at such an achievement. This article describes the two processes under development at the Board's Coal Research Establishment (CRE) for extracting solvents from coal. One yields up to half a ton of petroleum-like liquids, plus some byproducts, from a ton of coal. The other is an entirely novel method of extraction using super-critical gases under pressure.

PYROLYSIS AND CRACKING

REFER ALSO TO CITATION(S) 50, 62

103 (CONF-780723—6) **Pyrolysis of bituminous coal blocks.** Westmoreland, P.R. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From 4. underground coal conversion symposium; Steamboat Springs, CO, USA (17 Jul 1978).

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Internal heat and mass transfer resistances were observed to affect the pyrolysis of bituminous coal blocks in experiments at Oak Ridge National Laboratory (ORNL). Pyrolysis, the reaction step which occurs after drying and before gasification, is conventionally studied by the rapid heating of powdered samples so that internal resistances can be minimized. Because monolithic coal rather than powdered coal is reacted in underground coal gasification (UCG), the measurement of differences between powder and block pyrolysis is particularly important to the successful, broadly applicable modeling and development of UCG. In a block pyrolysis reactor at ORNL, 0.15-m (6-in.)-diam cylinders of bituminous coal were heated at 0.3, 3, or 14°C/min; in inert gas (Ar) and in H_2; and to maximum pyrolysis temperatures of 600 to 1000°C. In the tests performed at higher heating rates, a significant reduction in swelling of the coal was observed which can be correlated with the steep temperature gradients caused by heat transfer resistances. Also, at higher heating rates, pyrolysis gas evolution was increased as oil and char yields decreased. Such behavior is evidence of secondary cracking reactions caused by a combination of the steep temperature gradients and mass transfer resistances.

104 (FE-MIT—2295T27-3) **Coal pyrolysis by hot solids from a fluidized bed combustor. Quarterly progress report, December 1, 1977—February 2, 1978.** Longwell, J.P.; Howard, J.B.; Peters, W.A.; Yeboah, J.Y.; Alexander, G.; Nwalor, J.; Viarengo, S.; Virosco, J.; Brundage, S.; Hulseman, R. (Massachusetts Inst. of Tech., Cambridge (USA)). Mar 1978. Contract EX-76-C-01-2295-027. 9p. Dep. NTIS, PC A02/MF A01.

The objective of this study is to determine the effect of reaction conditions, especially inorganic calcium salts (e.g. fully calcined dolomite), prevalent in the hot solids from a fluidized bed combustor, on the yields, composition, heating values, and sulfur and nitrogen contents of coal pyrolysis products. Experiments will be performed in a 2" I.D. fluidized-bed pyrolyzer using two coals of commercial importance (Montana Lignite, low sulfur, noncaking, and Illinois No. 6, high sulfur, caking), over the following range of operating conditions: total pressure (1 to 20 atm of N_2), final temperature (800 to 1600°F), coal feed rate (0.3 to 5 lb/hr), CaO/coal weight ratio (0 to 50), coal and lime particle size distribution (250 to 500 μm) and fluidizing gas velocity (0.6 to 1 ft/s of N_2). Correlations and predictive models will be developed from the experimental data, and the sulfur and nitrogen content of successively distilled fractions of the liquid product determined. A preliminary assessment of technical and economic feasibility will be carried out by subcontract.

105 Characterization of the heavy products of coal pyrolysis. Gavalas, G.P.; Oka, M. (Calif Inst of Technol, Pasadena). *Fuel;* 57: No. 5, 285-288(May 1978).

In order to obtain information about the production mechanism of large molecules in coal pyrolysis, a subbituminous and two bituminous coals were heated at 500°C for 30 s under vacuum. The heavy products were dissolved in tetrahydrofuran (THF) and analyzed. The results are combined with elemental analysis data to obtain structural parameters of the extracts and pyrolysates. 16 refs.

106 Pyrolysis of carbonaceous materials with solvent quench recovery. Green, N.W.; Duraiswamy, K.; Lumpkin, R.E.; Knell, E.W.; Mirza, Z.I.; Winter, B.L. (to Occidental Petroleum Corp.). US Patent 4,085,030. 18 Apr 1978. Filed date 25 Jun 1976. 36p.

In a continuous process for recovery of values contained in a solid carbonaceous material, the carbonaceous material is comminuted and then subjected to flash pyrolysis in the presence of a particulate heat source to form a pyrolysis product stream containing a carbon containing solid residue and volatilized hydrocarbons. After the carbon containing solid residue is separated from the pyrolysis product stream, values are obtained by condensing volatilized hydrocarbons. The particulate source of heat is formed by oxidizing carbon in the solid residue. Apparatus useful for practicing this process is disclosed.

SOLVENT EXTRACTION

REFER ALSO TO CITATION(S) 11, 102

107 Thermal cleavage of chemical bonds in selected coal-related structures. Benjamin, B.M.; Raaen, V.F.; Maupin, P.H.; Brown, L.L.; Collins, C.J. (Oak Ridge Natl Lab, Tenn). *Fuel;* 57: No. 5, 269-272(May 1978).

An assessment is made of the solvent refining method of coal for converting coal into liquid fluids. Solvent-refined coal is produced in processes in which coal is heated with hydrogen-donor solvents. From it, oil, asphaltene, and preasphaltene fractions can be separated. The sizes of the molecules in these fractions are smaller than the sizes of those in the starting coal. An investigation was also made of the bond-breaking processes by determining what kinds of bonds rupture when each of a large number of carefully selected model compounds was subjected to the conditions of asphaltene formation. Both tetralin and vitrinite from Illinois No. 6 coal were used as hydrogen donors. The products of chemical breakdown of the model compounds are presented in several tables. 21 refs.

108 Extraction increase of coals treated with alcohol-sodium hydroxide at elevated temperatures. Makabe, M.; Hirano, Y.; Ouchi, K. (Hokkaido Univ, Sapporo, Jpn). *Fuel;* 57: No. 5, 289-292(May 1978).

Taiheiyo coal has been reacted in an autoclave with sodium hydroxide in ethanol. The extractability of the product with pyridine and ethanol increased remarkably as either the reaction temperature or the sodium hydroxide concentration rose. Under the same reaction conditions, the younger the coal the greater the extraction. The main reaction is hydrolysis, but other subsidiary reactions are also taking place. From a blank test, ethanol was found to react almost quantitatively with sodium hydroxide and water to produce sodium acetate and hydrogen gas. 8 refs.

BY-PRODUCTS

109 (FE—EES-78/5) **Economics of producing ammonia from coal by pressurized entrained and Koppers—Totzek gasification.** Morel, W.C.; Yim, Y.J. (Department of Energy, Morgantown, WV (USA). Process Evaluation Office). 1978. 13p. (CONF-780902—6). Dep. NTIS, PC A02/MF A01.

From American Chemical Society meeting; Miami, FL, USA (10 Sep 1978).

The demand for fertilizer will steadily increase as the world population continues to grow at a rapid rate. Almost all nitrogen fertilizer is derived from ammonia. Natural gas is the raw material to produce almost all the ammonia in the United States, but its availability for industrial use will decrease significantly in the future. Domestic consumption of natural gas will have top priority especially during the winter months. By 1990 the present administration plans to phase out natural gas for industrial use. Therefore, a substitute raw material for ammonia production will be needed to supplement and eventually replace natural gas. Coal, our richest fossil energy resource, is a likely possibility to replace natural gas. An economic evaluation of ammonia production from coal-derived hydrogen and air-derived nitrogen, based on a 1,000-ton-per-day capacity, is presented. Two coal entrained gasification systems for producing the hydrogen requirement are compared—one which operates at 30 atmospheres, and the other, Koppers-Totzek, which operates at a slightly higher than atmospheric pressure. Two different coals—Illinois No. 6 and Montana subbituminous—were considered for each system. The estimates are based on January 1977 cost indexes. Average selling prices of the ammonia were determined by using discounted cash flow (DCF) rates of 12, 15, and 20% at various coal costs. No inflation factors are included during the life of the plant. Pollution abatement considerations have been incorporated. Some of the economic and technical details are included for the two systems.

PROPERTIES

REFER ALSO TO CITATION(S) 3, 24, 46, 50, 85, 86, 95, 105, 107, 132

110 (FE—2030-10) **Characteristics of American coals in relation to their conversion into clean energy fuels. Quarterly technical progress report, October—December 1977.** Spackman, W.; Davis, A.; Walker, P.L.; Lovell, H.L.; Essenhigh, R.H.; Vastola, F.J.; Given, P.H.; Suhr, N.H. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Mar 1978. Contract EX-76-C-01-2030. 85p. Dep. NTIS, PC A05/MF A01.

The Penn State/DOE Coal Sample Bank has been expanded. A total of 54 characterized coal samples and 232 selected printouts of coal data were provided upon request to the coal research community. Work has been conducted using nitrogen as a pyrolysis medium at 808°C and seven size grades of the Texas Darco lignite (PSOC-412) as starting material. This work was intended to extend previous work on the effects of particle size on pyrolysis. A study is being made into the effects of low temperature oxidation on the agglomerating properties of caking coals. The effect of preoxidation in air of a highly caking coal at different temperatures on weight loss during pyrolysis up to 1000°C and reactivity of resultant chars to air at 475°C has been investigated. Preoxidation has essentially no effect on weight loss during pyrolysis below 450°C. At higher temperatures, however, preoxidation results in a decrease in weight loss. Preoxidation markedly enhances subsequent char reactivity. Differential scanning calorimetry and thermogravimetric analysis have been used to study the interaction between oxygen and an unactivated Saran carbon. In the range 125-227°C, chemisorption of oxygen, though the predominant process, is associated with a gasification reaction. The rate of the latter reaction is much higher than extrapolated from the Arrhenius plot in the temperature range 450-550°C. In the temperature range 450-850°C, gasification kinetics have been studied by the TGA technique. Plots of burn-off versus reaction time are linear over the 15-65% burn-off range. The Arrhenius plots consist of three distinct straight lines of different slopes, indicating that the gasification reaction occurs in three different zones.

111 (FE—2030-TR9) **Study of the interrelationships among chemical and petrographic variables of United States coals.** Waddell, C.; Davis, A.; Spackman, W.; Griffiths, J.C. (Pennsylvania State Univ., University Park (USA). Coal Research Section). Mar 1978. Contract EX-76-C-01-2030. 252p. Dep. NTIS, PC A12/MF A01.

Multivariate statistical techniques are used in a study of the interrelationships among various coal properties. The properties chosen for study are the components of the ultimate analysis (carbon, hydrogen, organic sulfur, nitrogen and oxygen); moisture; volatile matter; calorific value; maximum reflectance of the vitrinite-group macerals; and the relative proportions of the vitrinite-, liptinite-, and inertinite-group macerals. The coals included in the study are from four coal provinces (Eastern, Interior, Rocky Mountain, and Northern Great Plains) and range in rank from lignite to anthracite. A coal's characteristics, properties, and utilization behavior are determined by the maceral and mineral materials composing the coal. The level of coalification achieved by the maceral materials is of critical importance in fixing the properties. A factor analysis performed on all data together indicates that most variation in the data set is correlated with changes in rank (variables which vary with rank include carbon, oxygen, calorific value, moisture, volatile matter, and reflectance). The maceral groups account for the next greatest amount of variation. Nitrogen and sulfur are each independent of all other variables. A cluster analysis indicates that the data set represents a continuum with no distinct groups; however, the data set may be dissected into four groups distinguished from each other on the basis of rank, on the relative proportions of the maceral groups, and on the organic sulfur content. Factor analyses of the individual groups provide insights into coalification at various stages of rank.

112 **Fractionation of peat-derived bitumen into oil and asphaltenes.** Cavalier, J.; Chornet, E. (Univ of Sherbrooke, Que). *Fuel;* **57**: No. 5, 304-308(May 1978).

The present work was aimed at gaining information on the composition of the bitumen as measured by the fractions of asphaltenes and oils. The role of the different variables involved in the conversion was studied. It was established that the proportion of oils in the bitumen varies considerably, between 30 and 60% a function of the experimental conditions chosen. CO is preferred over H_2 as the hydrogenating gas. Temperature is the most important single variable, with 350-375°C as a suitable range for the conversion. 21 refs.

113 **Fluorescence spectroscopy in the characterization of coal-derived liquids.** Karshaw, J.R. (Fuel Res Inst of S Afr, Pretoria). *Fuel;* **57**: No. 5, 299-303(May 1978).

Coal-derived liquids, such as those obtained on hydrogenation of coal, are complex mixtures of widely different compounds. They are predominantly aromatic in nature and contain many polyaromatic hydrocarbons. Knowledge of these polyaromatic hydrocarbons is of importance for the further processing of coal-hydrogenation liquids, for environmental and health reasons. This paper demonstrates the potential of fluorescence spectroscopic analysis for the identification of polyaromatic ring systems in coal-hydrogenation liquids and coal extracts. 11 refs.

114 **Thermodynamics of adsorption of organic compounds on the surface of Bruceton coal measured by gas chromatography.** Larsen, J.W.; Kennard, L.; Kuemmerle, E.W. (Univ of Tenn, Knoxville). *Fuel;* **57**: No. 5, 309-313(May 1978).

Isosteric heats of adsorption of a variety of organic molecules on Bruceton coal were measured by gas chromatography. The time required for these measurements is much less than that required for adsorption equilibria in static systems and the implications of this are discussed. Both pyridine and methanol show highly specific interactions with this coal surface. For all other solutes examined, the interactions seem to be dominated by dipolar and London forces, hydrogen-bonding and acid-base interactions playing a small role. 23 refs.

115 **Sulphur in Indian coal and lignite: an appraisal.** Mukherjee, S.N. (Cent Fuel Res Inst, Dhanbad, India). *Chem. Age India;* **28**: No. 10, 817-821(Oct 1977).

The mode of occurrence of sulphur in different forms in coal is discussed. Available methods for desulphurization of coal are highlighted. It is found that Indian coals are generally lower in sulphur than those of other countries. Intensive use of coals with the growth of coal-based industries will pose a problem on air pollution at least in industrially developed areas of the country.

116 **Computer estimation of the ash content of coal strata.** Kulinkovich, A.E.; Gotynyan, V.S.; Kolisnichenko, V.G.; Golovtsyna, L.G. *Razved. Okhr. Nedr;* No. 8, 48-51(1976). (In Russian).

The code "Zolnost-1" system has been developed for the determination of the coal ash content by means of gamma logging. The system is based on the statistical relation between the ash content and the measured intensity of the coal bed gamma radiation. The major ash component is represented by alumosilicates whose content is responsible for the enhanced ash content and the intensity of the coal gamma radiation respectively. The above statistical relation discontinues at the enhanced coal bed radioactivity. In this case the method is unsuitable. The technique for gamma logging data input into a computer is described. The operation results of the system are printed out in a digital form. The time spent by the system for data processing for one bed intersection is 15-30 s, and for data preparation 5-7 min.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 5, 6, 7, 8, 14, 35, 147, 171, 567

117 (ANL/ECT—3(App.D)) **Environmental control implications of generating electric power from coal. 1977 technology status report. Appendix D. Assessment of NO/sub x/ control technology for coal fired utility boilers.** (Argonne National Lab., IL (USA)). Dec 1977. Contract W-31-109-ENG-38. 593p. Dep. NTIS, PC A25/MF A01.

An NOx control technology assessment study was conducted to examine the effectiveness of low-excess-air firing, staged combustion, flue gas recirculation, and current burner/boiler designs as applied to coal-fired utility boilers. Significant variations in NOx emissions exist with boiler type, firing method, and coal type, but a relative comparison of emissions control performance, cost, and operational considerations is presented for each method. The study emphasized the numerous operational factors that are of major importance to the user in selecting and implementing a combustion modification technique. Staged combustion and low-excess-air operation were identified as the most cost-effective methods for existing units. Close control of local air/fuel ratios and rigorous combustion equipment maintenance are essential to the success of both methods. Flue gas recirculation is relatively ineffective and has the added concern of tube erosion. More research is needed to resolve potential corrosion concerns with low-NOx operating modes. Low-NOx burners in conjunction w 'h a compartmentalized windbox are capable of meeting a 0.6-lb/million Btu emission level on new units. Advanced burner designs are being developed to meet research emission goals of approximately 0.25 lb/MBtu.

118 (CONF-780611—12) **Ultrafiltration for coal gasification processes.** Anderson, G.L.; Bair, W.G.; Hudziak, J.A. (Institute of Gas Technology, Chicago, IL (USA)). 1978. Contract EX-76-C-01-2336. 26p. Dep. NTIS, PC A03/MF A01.

From AIChE symposium; Philadelphia, PA, USA (4 Jun 1978).

Commercial coal gasification plants consume a minimum of 7000 gallons of water per minute. To maintain this minimum, extensive condensate recovery and recycle will be required. A process stream of particular importance is the waste char stream. This stream represents between 400 and 1600 gallons per minute of recoverable water. A preliminary investigation has been made to determine the technical and economic feasibility of applying ultrafiltration technology to this problem. Based on experimental data, a preliminary economic analysis indicates that significant savings compared with costs incurred using conventional technology.

119 (HCP/T2549—18) **Development of potential uses for the residue from fluidized bed combustion processes. Quarterly technical progress report, March—May 1978.** Minnick, L.J. (Minnick (L.J.), Inc., Plymouth Meeting, PA (USA)). Aug 1978. Contract EF-77-C-01-2549. 35p. Dep. NTIS, PC A03/MF A01.

Because of basic differences in the composition of the spent bed residue and fly ash materials from FBC boilers, these materials should be collected separately and not mixed. Some conditioning or hydration of FBC residue is necessary in order to properly prepare the residue for use in structural compositions without subsequent detrimental volume expansion. The level of conditioning plays a significant role in the performance of the material. The extent of the conditioning must be more fully investigated, but may be related to the chemical composition of the residue. Chemical analyses of FBC materials indicate basic similarities of residues from boilers in which limestone was used as the sorbent material in the bed. Likewise, the composition of residues from boilers in which dolomite was used as the sorbent are similar to each other, although different from the limestone bed materials. Continued monitoring of stabilized road base specimens containing FBC residue under low temperature curing conditions has shown surprisingly good compressive strength development, although the pattern of strength gain is sometimes erratic. Of the compositions tested to date, involving FBC residue percentages ranging from 6 to 80 percent by weight, long-term compressive strength in excess of 2500 psi were obtained in nearly all cases. Proper blending of FBC residue and FBC fly ash seems to produce a material that can be extruded and fired into a synthetic lightweight aggregate product, although further refinement of the blend formulation is needed. Placement of FBC residue in uncovered stockpiles will result in a hardening or cementing of the exposed outer surface of the stockpile.

120 **Removal of SO_2 from stack gases: a review of technology and waste by-product disposal.** Brown, W.D.; Brown, E.C. (Ontario Research Foundation, Mississauga). *CIM Bull.;* **71**: No. 795, 82-89(Jul 1978).

Seven processes are sufficiently advanced to be used commercially for the removal of SO_2 from dilute waste gas streams. These processes are the lime/limestone, magnesium oxide, sodium carbonate, aqueous carbonate, double alkali, Wellman-Lord/Allied Chemical and Chiyoda Thoroughbred 101. Of these, the lime/limestone process has received by far the most study and use, and is the popular choice for flue gas desulphurization (FGD) installations. Consequently, large quantities of waste sludge from these units will be produced and the need for landfill sites will become critical. Government regulation and the high cost of disposal may eventually increase the feasibility of utilizing such wastes as raw materials, most probably for the construction industry.

121 **Oakdale colliery.** Watson, T. *Colliery Guardian;* **226**: No. 3, 146, 148, 150-152(Mar 1978).

The National Coal Board (NCB)'s collieries are divided for central purposes into 12 areas and the South Wales Area includes over 40 collierires with a workforce of some 35,000. This article describes the NCB's reorganization of Oakdale Colliery, and presents a detailed account of the innovations and new equipment installed recently at Oakdale.

122 **SO_2 control technologies: commercial availabilities and economics.** Ponder, W.H.; Stern, R.D.; McGlamery, G.G. (US EPA, Ind Environ Res Lab, Research Triangle Park, NC). *Energy Commun.;* **4**: No. 2, 175-212(1978).

By 2000, power plants alone will emit about 80 million tons of SO_2 per year unless control technology is used to reduce the emissions. Threin lies the complex energy/environment/economic problem: the urgent need to become a coal-fired economy while simultaneously safeguarding the quality of the environment at reasonable cost. This paper addresses the principal SO_2 control technologies that are expected to contribute to the solution. Emphasis is placed on the status of commercial availability and the costs of each alternative technology. 28 refs.

123 **Gas desulfurization with the help of lime.** Dumont, P.; Bonsang, R. *Ann. Mines Belg.;* No. 10, 919-929(Oct 1977). (In French and Flemish with English abstract).

The pollution caused by emissions of sulphur dioxide in waste gases is regulated in Belgium by Royal Decree. Among the provisions aimed at reducing the volume of SO_2 emission is one measure which should be employed in Belgium: scrubbing the waste gases in alkaline lime water. The lime-scrubbing process is reliable and offers the most economical way of removing the SO_2. However, it has the disadvantage of yielding a byproduct consisting of calcium sulfites and sulfates. Results of a study program which explores the possibility of utilizing these sludges are discussed, showing that atmospheric oxidation of the sludges is much easier to achieve than generally thought.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 55, 58, 87, 119, 122, 182, 183, 1426, 1554

124 (ANL/IAPE/TM—78-3) **Empirical investigation of the factors affecting socioeconomic impacts from energy development.** Stenehjem, E.J.; Hoover, L.J.; Krohm, G.C. (Argonne National Lab., IL (USA)). Sep 1977. Contract W-31-109-ENG-38. 84p. Dep. NTIS, PC A05/MF A01.

Many studies have been conducted to predict the socioeconomic effects associated with site-specific coal development projects at specific sites. Most socioeconomic studies have forecast the impacts on employment and population of a specific energy technology at a particular site. Such forecasts have become important components of the environmental impact analyses of site-specific operations in coal extraction and conversion. These studies provide government, industry, and interest groups with important information about the expected social and economic changes at a particular site. However, such studies are of little value in evaluating and comparing alternative sites or of use in determining regional patterns of development. To assist officials in both the public and private sectors in evaluation of how facilities are sited in a region, and methods of coal utilization that will minimize social and economic impacts, a more general analysis is required. This paper, an initial attempt at such an analysis, is intended as a basis for discussion so that subsequent analysis can more thoroughly address the issues. By using an approach developed at Argonne for its Regional Studies Program, the socioeconomic consequences of alternative rates and types of coal development in a variety of potentially exploitable counties are projected. The results of these miniature case studies are then used to evaluate the sensitivity of the projected impacts to site- and technology-specific factors. By contrasting the socioeconomic consequences of identical coal technologies in counties differing markedly in economic, geographic, and demographic characteristics, the influences of these characteristics on the rate and magnitude of such impacts are described. Also, the influence of different rates and types

of coal development are evaluated by comparing their expected socioeconomic consequences in nearly identical counties.

125 (ANL/IAPE/TM—78-5) **Constraints on coal utilization due to air quality requirements.** Kellermeyer, D.A.; Cirillo, R.R.; Dauzvardis, P.A. (Argonne National Lab., IL (USA)). Oct 1977. Contract W-31-109-ENG-38. 13p. Dep. NTIS, PC A02/MF A01.

Combustion of coal in utility boilers is expected to produce the greatest quantity of atmospheric pollutants from coal utilization. Siting of major utility coal boilers will be severely constrained in non-attainment areas and near Class I PSD areas. Siting will be possible for the foreseeable future in Class II and Class III areas; however, the pattern of siting will be constrained and limitations will be placed on facility capacity at any one site. Trace-element emissions from these facilities have not been shown to produce significant impacts, but further research is required to substantiate any possible impact. Current studies of the effects of sulfate aerosols that may be transported interregionally may indicate the need for substantially reduced sulfur emissions in all areas of the country. Large industrial facilities will have constraints similar to those for utilities. The implications are for potentially significant changes in future patterns of industrial siting. Much future coal utilization may be in production of synthetic fuels (e.g., high-Btu gas, low-Btu gas, and liquids) from coal. Most emissions of sulfur dioxide, nitrogen oxides, and TSP from facilities for synthetic fuels are expected to be from the boilers used to drive the processes. These boilers are expected to be subject to emission standards equivalent to those for utility boilers in electrical generating facilities. Emissions of sulfur dioxide from a gasification plant will be about 10 to 20% of those from a coal-fired electrical power plant with equivalent energy output; TSP emissions will be about one-third. The potential exists for the emission of significant amounts of hazardous hydrocarbons produced in the conversion process, but the magnitude of this impact cannot now be measured. Emissions also occur due to extraction, transportation, and processing of coal. Compared with direct combustion, these emissions are small.

126 (ANL/IAPE/TM—78-6) **Agenda for analysis, assessment and research.** Hilton, M.L. (Argonne National Lab., IL (USA)). Dec 1977. Contract W-31-109-ENG-38. 70p. Dep. NTIS, PC A04/MF A01.

The goals of the NCUA program are to identify the health, socioeconomic and environmental impacts of possible levels of future national and regional coal development, define where those impacts may cause problems or constraints to increased coal use, and identify and evaluate alternative strategies for alleviating the problems or constraints. In conjunction with this first year assessment, an extensive effort was undertaken to contact state and regional organizations to identify the major coal-related issues of concern to them. This report summarizes the results of those contacts and describes NCUA studies responding to the issues.

127 (PB—278175) **Environmental assessment of high-Btu gasification: annual report. Annual report, May—October 1977.** Ghassemi, M.; Murray, C. (TRW Environmental Engineering Div., Redondo Beach, CA (USA)). Feb 1978. Contract EPA-68-02-2635. 87p. NTIS PC A05/MF A01.

The report gives results of initial efforts of a 3-year program, initiated May 3, 1977, with the dual objectives of assessing environmental impacts associated with technologies for converting coal to high-Btu gaseous fuel and to identify control technologies required to reduce or eliminate adverse environmental impacts associated with commercial operation. The program consists of: evaluating existing process and environmental data; acquiring supplementary data through sampling and analyzing process waste streams; and environmental assessment and process engineering support studies. Most of the initial effort was in connection with acquiring and analyzing the data base, and locating potential sites for field programs. A modular approach was chosen for analyzing and presenting data on gasification, gas treatment, pollution control, and integrated facilities. Draft gasification data sheets were prepared for some of the processes considered. Preliminary discussions were held to enlist the cooperation of process developers in identifying potential sites for environmental sampling and in arranging for such sampling.

128 **Method for adenosine 5'-triphosphate measurement on coke waste activated sludge.** Russell, J.; Gauthier, J.J. (Univ. of Alabama, Birmingham). *Appl. Environ. Microbiol.;* **35**: No. 2, 450-452(Feb 1978).

Measurement of adenosine 5'-triphosphate (ATP) in coke waste activated sludge can provide a simple method for estimating the levels of viable microbes in the sludge. However, the presence of inhibitors such as phenol in the sludge interferes when the luciferin-luciferase method is used to measure ATP. These inhibiting substances can be removed from the sludge before extraction of ATP by washing the cells with dilute sodium dodecyl sulfate.

129 **Dust measurement.** Courbon, P. (Cent d'Etude et Rech des Charbon de Fr (CERCHAR)). *Ann. Mines;* **184**: No. 1-2, 31-38(Jan-Feb 1978). (In French).

After discussing the behavior of dust particles suspended in the atmosphere and the respiratory tract of human beings, the author reviews various dust-measuring techniques used in France, especially those employed for the gas-containing coal seams, places of work, and the environment. Particular reference is made to the following subjects: Stokes' law, alveolar retention curve; sampling probe, the concept of isokinetics and selection measurement sites; numerical measurements, filtering equipment and turbo-collectors, as well as individual measurements. Finally, prospects for automated dust measurement are outlined.

130 (NP-tr—2034) **Relationship between soil reclamation measures and yields of agricultural products on the Opatovice power plant ash dump.** Maly, V. Translated from *Ved. Pr. Vysk. Ustavu Melior.;* **39**: No. 13, 147-165(1973). 23p. British Library Lending Div., Yorkshire, Eng.

The problem of biological soil reclamation was studied on a sample plot situated on the ash disposal dump ground of the opatovice power plant. The relationship between the thickness of earth spread over the ash materials (10, 30 and 50 cm) and the yields of agricultural products was investigated in the period 1965 to 1970. The results obtained showed that the highest yields of agricultural products were achieved on a plot with 50 cm cover of earth, slightly lower yields were obtained on plots with 30 cm cover and substantially lower yields were obtained on a plot with 10 cm cover and the lowest ones on the control (leached ash surfaces). In individual years investigation was made into the changes in physical and chemical properties of plots covered with earth and control plots on the dumping ground. The improvement of physical properties occurring within a six-year period is obviously connected with soil cultivation, fertilizing and growing of given agricultural crops. The increase in basic nutrients (N, K_2O, P_2O_5, and CaO) during the six-year period was more apparent for the sail cover than for dump material, where the supplies, especially of N and P_2O_5, were insufficient. The results obtained lead to the conclusion that the yield of agricultural crops depends on the thickness of earth cover spread over the original material; the differences in yields between the 30 and 50 cm layers are not significant but are both markedly greater than on the 10 cm cover and on the control.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 116, 487

131 **In situ analysis of coal using a ^{252}Cf—Ge(Li) borehole sonde.** Senftle, F.E.; Tanner, A.B.; Philbin, P.W.; Boyton, G.R.; Schram, C.W. (US Dep of Inter, US Geol Surv, Reston, Va). *Min. Eng. (N.Y.);* **30**: No. 6, 666-674(Jun 1978).

A borehole sonde using a ^{252}Cf neutron source and a Ge(Li) gamma-ray detector was field tested in a coal bed in Belmont County, Ohio, to ascertain whether such a device could be useful as a coal-exploration tool. As the sonde was lowered into the borehole, successive spectra were accumulated over short time intervals. The intensities of the capture gamma rays from hydrogen and of decay gamma rays from aluminum were determined simultaneously in each spectrum. A log of the intensities versus depth shows the depth and thickness of the coal bed. Delayed gamma-ray analyses of the core were also made on the surface in the vicinity of the borehole in a fixed-geometry irradiation facility using the detector in the borehole sonde. 24 refs.

MINING

REFER ALSO TO CITATION(S) 121, 159, 173, 179, 180, 181, 182, 280, 1240, 1241

132 (FE—1231-11) **Design optimization in underground coal systems. Interim report, October—December 1977.** Haycocks, C.; Breeds, C.D. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Div. of Minerals Engineering). Mar 1978. Contract EX-76-C-01-1231. 54p. Dep. NTIS, PC A04/MF A01.

Results of measurements of the mechanical properties of coal samples are summarized: for cubical specimens, the Gaddy equation, $K = S\sqrt{d}$, is the best method of relating strength and size (K is a constant, S is the strength of 2 to 24 in cubical coal specimens and d is the edge length of the cube). Some dependence of measured strength on the loading rate was found; it was concluded that the loading rate should be constant and between 50 and 150 psi/sec. Cubes are stronger than cylinders (of the same area), but the difference decreases as sample size increases, and is small for the larger

samples. Information and computer programs are being developed for longwall mining simulation and economic analysis. Roof truss type supports have been studied further by theory, photoelastic models and experimental and field data. Recommendations concerning the efficient installation and usage of roof trusses were made. (LTN)

133 (FE—9012-1) **Longwall/shortwall mine equipment availability and delay analysis. Final report.** Curry, K.C.; Lohman, G.M.; Metcalfe, M.A. (Jet Propulsion Lab., Pasadena, CA (USA)). Apr 1978. Contract ET-75-I-01-9012. 78p. Dep. NTIS, PC A05/MF A01.

This study has considered an overview of the equipment availability for one longwall mine and one shortwall mine, each modeled as a system of mining components linked in series, so that a delay of any single component causes an equal delay in the entire system. Through computerized statistical reduction of delay and shift data from selected shift reports for the two mines, each for a period of 11 months, and using this series model, bottleneck components and major trends in delays have been identified. These bottleneck components are the shearer, face conveyor, and external conveyors in longwall mines; and the miner, supports, shuttle cars, and external haulage in shortwall mines. Except for conditions shared by components—such as the electrical power system and cables, geologic conditions, personnel, etc.—components were generally found to experience delays independently. Monthly cycles of delays were found for several components, suggesting potential maintenance frequencies. The various trends in delays are at best drawn from insufficient data, and at worst unexplainable using the available data. Hence, specific recommendations for the design, use, or maintenance of any specific piece of equipment cannot be made with certainty. Limitations posed by the available data have necessarily prompted numerous specific recommendations to improve future data collection. More profitable recommendations can then be made about the equipment and its operation. The data recommendations seek to improve the depth, detail, and duration of delay information, as well as the breadth of factors relevant to coal production. In addition, specialized studies of the components found to be critical in this study are suggested.

134 (FE—9012-2) **Longwall mine availability and delay analysis: Phase II. Part I. Technical analysis.** Curry, K.C.; Heimburger, D.A.; Metcalfe, M.A. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Dec 1976. Contract ET-75-I-01-9012. 59p. Dep. NTIS, PC A04/MF A01.

The conclusions and recommendation made as a result of the study will be presented in the Task Final Report for Phase III No. 5040-46. The approach taken in this report is to analyze the data and present the results in a manner that allows flexibility in interpretation. The description of analyses, methods, and results should give the planner a good overview of how such analysis works, and the kind of results that can be obtained. The longwall mining method currently accounts for only 4 percent of the U.S. annual coal production, but is rapidly gaining acceptance. The Bureau of Mines took steps toward encouraging the usage of longwall mining by establishing a demonstration project with a western mining company. The data used in this study was furnished to the BOM by the mining company as part of the contract for the demonstration project. The source of the data provided by the mine was the shift foreman's Daily Longwall Production Report. A methodology was established to define the meaning of "availability" in the context of this analysis. A separate analysis was made for both inherent and longwall delays. The proportion of longwall delay time representing each system component was presented both tabularly and graphically for each month of the study period. Finally, an analysis was made of the repair skill mix required for each component. A mathematical model was presented that represented the availability of a system of series components. A formula of the model takes into account 2 parameters of each component: its Mean Time To Repair (MTTR) and its Mean Time Between Delays (MTBD). Using the formula allowed an investigation of the change in overall system availability as a result of varying the individual parameters. The Time To Repair distributions were tested for each component. Only the supports catagory was determined to be drawn randomly from an exponentially distributed population.

135 (FE—9012-4) **Shortwall mine availability and delay analysis: Phase II. Part I. Technical analysis.** Curry, K.C.; Heimburger, D.A.; Metcalfe, M.A. (Jet Propulsion Lab., Pasadena, CA (USA)). Apr 1978. Contract ET-75-I-01-9012. 63p. Dep. NTIS, PC A04/MF A01.

Shortwall mining originated in Australia in 1959. The current self-advancing steel roof support system evolved, as a result of this experience. The shortwall method relies heavily on mechanization and a systematic procedure for mining and removing coal. To encourage the use of shortwall mining, the Bureau of Mines agreed to provide the roof support system, spare parts for its maintenance, and let a research contract for a rock mechanics study on the shortwall. The data provided by the mine were from the Section Foreman's Daily Report. Vital delay and production information was coded from these reports and entered in machine readable form to the computer system. A general purpose database management system (NOMAD) was used to build an extremely flexible computer database to provide the scores of sorts, reports and summaries necessary to completely analyze the data. A special purpose statistical database (SPX) was also built to analyze in detail certain statistical properties on a subset of the data pertaining to delay times. The availability of the shortwall system was determined to be 68.2 percent of the available working time (total time minus the inherent delay time). The times were summarized for each source of delay for both inherent and shortwall delays. The results indicate that the miner, shuttle cars, and supports show the most potential for increasing system availability. These potentials might be realized by enacting new procedures, stocking spare parts, choosing more reliable vendors, etc.

136 (NP—23413) **Mining year book, 1978.** (Colorado Mining Association, Denver (USA)). 1978. 215p. Colorado Mining Association, Denver $10.00.

Papers presented at the 81. annual meeting of the National Western Mining Conference and Exhibition; Denver, CO, USA, 9 Feb 1978.

The Mining Year Book of the Colorado Mining Association has been entered into EDB and ERA as a unit, with indexing to cover topics discussed in the individual papers. (LTN)

137 **Present state of development of face conveyors in the West German coal mining industry.** Henkel, E.H. (Bergbau-Forsch, Essen, Ger). *Min. Eng. (London);* **137**: No. 202, 573-579(May 1978).

An overview is given of the state of development of face conveyors in the German hard coal mining industry. The factors that have influenced this development are discussed, surface trials with chain scraper conveyors are described, and investigations into drive problems of face conveyors are covered. These investigations on face equipment driven by chain at the Steinkohlenbergbauverein test site in Essen and underground have produced results which have had a fundamental influence on the future development of drives.

138 **Strategy for mining research and development in the United Kingdom.** Tragelles, P.G. (Natl Coal Board, Bretby, Engl). *Min. Eng. (London);* **137**: No. 202, 587-599(May 1978).

The author deals with the strategy on which current U.K. mining research and development work must be based if it is to make its maximum contribution to the industry's safety and productivity. This strategy is founded on the progress of projects through four phases: Research, Development, Demonstration and Exploitation. The work currently being done by MRDE (Mining Research and Development Establishment) in each of these four phases is described, beginning with the long-term research face. In the short term, the key problem now facing the industry is the inconsistency of performance of established longwall face equipment.

139 **Entries from the surface to new mines.** Simpson, D.N. (Natl Coal Board). *Min. Eng. (London);* **137**: No. 202, 601-615(May 1978).

Having established the need for increased activity in shaft sinking and drivage of drifts from the surface to new reserves of coal recently proved in the UK, to meet anticipated increased demands for coal up to the year 2000 and beyond, the author examines some of the causes of delay in developing new collieries since 1940 and suggests means of achieving full production earlier at new mines. Recent experience in Poland and the USA is described, and a more rationalized approach to sinking or drifting through weak or water-bearing ground, the most frequent cause of delay hitherto, is outlined. 23 refs.

140 **Apparatus for coal mining in-cutting and out-cutting.** Justice, J.C.; Delli-Gatti, F.A. Jr. (to Coaltex, Inc.). US Patent 4,082,362. 4 Apr 1978. Filed date 18 Jan 1977. 14p.

Apparatus for forming bores in coal seams and the like and enlarging preexisting bores is described. A mining machine includes a nonrotatable body member, a conveyor in line with the body member, a pilot head, and a pair of wing cutters mounted to the body member for pivotal movement with respect to the body member. Structure is provided for moving coal or the like cut by the wing cutters during out-cutting toward the sides of the bore, the structure including a pair of shields, one associated with each wing cutter and disposed between the wing cutter and the body member and pilot head, and a generally conical member coaxial with the shaft for rotation of the pilot head. Stabilization of the body member, etc., within the bore is provided by a pair of wheel sets spaced along the length of the conveyor, and a pair of right angle guide members vertically displaced from the wheel structure of one of the wheel sets. The back set of wheels may include a pair of vertically spaced wheels on each side of the conveyor, one wheel of each set engaging the roof of the bore while the other wheel engages the floor, and the

roof engaging wheel and floor engaging wheel may both be vertically adjustable. A roof cutter may also be provided including a cutting drum rotatable about a horizontal axis and a pair of chain cutters rotating the cutting drum and connected to a horizontal shaft that is stationary with respect to the body member.

141 Wide-web working with the in-web shearer at Florence colliery. Evans, H.C. (Natl Coal Board, West Area, Engl). *Min. Eng. (London);* **137**: No. 201, 527-536(Apr 1978).

The initial concpets for the introduction of an in-web machine giving wide-web extraction in a thin seam at this British coal mine are described. The equipment used, layout, initial problems after installation and operational experience with the Buttock Shearer and results obtained are all fully discussed, and finally conclusions are drawn. The system has incorporated equipment which is readily available, and results show that the concept of wide-web working in thin seams is right and that it is possible to have increased productivity within the limitations of a 6 ft 6 in. prop-free front distance. 1 ref.

142 Coalface surveyor. Donald, J.A. (Marconi Space and Def Syst Ltd, Engl). *Engineering (London);* **218**: No. 4, 345-348(Apr 1978).

The problem being tackled with the Coalface Surveyor is the very real one of keeping the coalface straight. At present, any attempt to keep the coalface straight depends on the judgment of the miner (plus periodic surveys) who is working literally in the dark having only limited line-of-sight visibility. Thus misalignment in the coalface can build up leading to increased machinery wear, poor roof control and may in certain cases prejudice safety. In the first instance the Coalface Surveyor provides the miner with information essential to maintain face alignment by continuously measuring the profile of the coalface. this information being presented on a graphical display. Ultimately, the Surveyor can be linked to the roof-support chock-control equipment giving complete automatic control of the face.

143 Effect of continuous miner parameters on the generation of respirable dust. Black, S.; Johnson, B.V.; Schmidt, R.L.; Banerjee, B. (Fairchild Inc). *Min. Congr. J.;* **64**: No. 4, 19-25(Apr 1978).

This paper presents the final results of a Bureau of Mines test program on the effects of both deep cutting and bit speed on respirable dust and specific energy and the impact these results will have on future coal-mining-machine designs. 5 refs.

144 Bureau of Mines research program on mine illumination. Bockosh, G.R. (US Bur of Mines). *Min. Congr. J.;* **64**: No. 4, 49-53(Apr 1978).

In demonstrating the feasibility and benefits of providing additional illumination in the working places of underground coal mines, the Bureau of Mines has illuminated 38 machines and four longwall faces in a total of 22 mines. These installations provide guidelines by which most of the machines utilized by the industry could be illuminated.

145 Few thoughts on heat loads in intake haulages. Hughes, R.O. (Deelkraal G.M. Co Ltd). *J. Mine Vent. Soc. S. Afr.;* **31**: No. 3, 50-53(Mar 1978).

The magnitude of the heat load in intake haulages is established and the equivalent cost in refrigeration is assessed. The expenditure per meter of haulage which could be justified to reduce the heat flow is calculated, and various methods of achieving this are suggested. 3 refs.

146 North Nottinghamshire area. Area profile. I. Watson, T. *Colliery Guardian;* **226**: No. 3, 131-145(Mar 1978).

This is the first in a series of articles giving information about individual areas of the National Coal Board (NCB) and the collieries within each area. The National Coal Board of Great Britain is responsible for all coal mining operations in that country. By far the greater part of the NCB's multifarious operations consist of all the management of some 243 "Deep Mine" units which produce approximately a total of 110 million tons of coal per year, with a workforce of some 240 thousand men.

147 Study of the possibilities for calculating dump drainages. Rechenberger, H. (Ingenieursch fuer Bergbau und Energ "Ernst Thaelmann", Senftenberg, E Ger). *Neue Bergbautech.;* **8**: No. 2, 83-88(Feb 1978). (In German).

Apart from vertical drainage installations (e.g. deep wells) used in East Germany in soft coal mining, the industry relies to a much greater extent on horizontal drainage facilities for dump drainage. While in the case of the former type of drainage the known calculating methods are applicable, in principle, to dump grounds and also are partly used for this purpose, there is a lack of suitable calculating methods for horizontal drainage and its planning is based only on experience in practice. Therefore, this study attempts to find the suitable calculating methods for horizontal drainage of coal mine dumps, mainly based on the examples calculating horizontal drillings that were published in the Soviet literature. 4 refs.

148 Mechanism of coal and gas bursts in the light of measurement results. Tarnowski, J. *Przegl. Gorn.;* **34**: No. 1, 1-7(Jan 1978). (In Polish).

T. Krzeminski's analysis of the negative drillability of coal at a certain distance ahead of the mine working face leads to a number of conclusions. In particular, when negative drillability occurs, there is a danger of coal and gas bursts. The occurrence of negative drillability is the result of the summing up in the coal seam of the energy of the overlying rock pressure and the gas sorption energy. Under real mining conditions there is a depth below which the quantity of energy accumulated in the coal seam exceeds the quantity of work required for the destruction of the ribside compactness of the outgassed and destressed part of the coal. Under such conditions the seam is in a state of unstable equilibrium, and coal and gas bursts can occur at any moment. 9 refs.

149 Effect of the kind of working on coal and gas burst hazards. Szirtes, L. *Przegl. Gorn.;* **34**: No. 1, 7-12(Jan 1978). (In Polish).

Three degrees of burst hazard are considered as a function of the magnitude of the stresses caused by various methods of carrying out mine development work. The first degree occurs in development work when traversing geological disturbances and opening the seam. The second degree occurs in driving roadways in zones of increased operating pressures close to the face. The third degree occurs in additive zones of increased operating pressures caused by mining the seam. 8 refs.

150 Trends of improvement of the system for determining the gasiness of coal seams. Borowski, J.; Matuszewski, J. *Przegl. Gorn.;* **34**: No. 1, 13-19(Jan 1978). (In Polish).

The current system of controlling the fire-damp hazard in mines consists in determining the gasiness of the seams and in improving methanometric measurements. The introduction of an extended system of determination of seam gasiness on the basis of two new methods is proposed. The direct borehole method consists in outgassing coal samples taken at faces from a deep level of the coal mass and placed in airtight containers. The indirect, desorbometric (operational) method consists in measuring the gas desorption from coal samples taken at faces from a deep level of the coal mass and in reading off the equivalent gas content and gas pressure from nomograms. 7 refs.

151 Iscor's Grootegeluk mine now preparing to produce by 1980. *S. Afr. Min. Eng. J.;* **89**: No. 4136, 35, 39(Jan 1978).

Iscor's Grootegeluk coal mine at Ellisras in the north western Transvaal is now planned to start production during 1980 when blend coking coal in the Witbank area is expected to become exhausted. The mine will be a major opencast operation and production is planned at 1,820,000 t of blend coking coal a year for the beneficiation plant, and about 2,200,000 t a year of middlings suitable for gasification or use in utilities.

152 Coking coal: South Africa's needs and resources reviewed. Horsfall, D.W. (Anglo Am Corp, Johannesburg, S Afr). *S. Afr. Min. Eng. J.;* **89**: No. 4136, 51, 56-57, 63(Jan 1978).

South Africa, having no natural oil or gas reserves, is heavily reliant on the coal mining industry to provide coal for use as a metallurgical reductant. Coking coal is produced by colleries in the Witbank area and--by the 1980s--will be produced at Iscor's new Grootegeluk colliery.

153 (NP-tr—2028) Technical and organisational methods in the arrangement and operation of hydraulically supported faces. Hess, H. Translated from *Glueckauf;* **98**: No. 8, 438-443(11 Apr 1962). 14p. British Library Lending Div., Yorkshire, Eng.

Pre-conditions for successful use of hydraulic face supports are careful engineering preparations, through training of the men and supervisory personnel and maintained technical and economic surveillance. Hydraulic single props are best used in cases where good roof control makes machine mining possible. Hydraulic single supports also provide considerable advantages in caving in steep seams. Special attention should be paid to rational repair operations as these are particularly important for the economics of hydraulic face supports: Powered hydraulic supports make special demands on roof consistency because of the repeated loading. To avoid extensive errors, careful preliminary investigations and trials should be carried out in a production face using a limited number of frames. High purchase costs for powered supports call for a high rate of advance if their use is to be economically justified.

154 (NP-tr—2029) SKBV papers session on face supports. Batzel, S. Translated from *Glueckauf;* **98**: No. 8, 429-432(11 Apr 1962). 11p. British Library Lending Div., Yorkshire, Eng.

In mechanization of the roof support operation we are coming up against a great number of problems in terms of mining, geology and machines. We are convinced that these call for the appointment of support engineers and recommend all collieries to

appoint engineers of this type. Exchange of experience can be promoted by papers, publications and committee work. Over and above this, SKBV is collating experience from faces with powered supports and is evaluating this with the object of providing an advisory service to collieries planning to introduce this type of support. I would urgently ask you to make use of this service, and here we have in mind not only the support engineers at the collieries but all other mining engineers, and ask them to inform SKBV of experience and results both positive and negative, subjective or objective. This is extremely important for the further development and wide implementation of powered supports.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 46, 151, 152

155 (ANL/IAPE/TM—78-8) **Western coal shipment on the Great Lakes: background and research needs.** Lewis, L.R.; Stupka, R.C. (Argonne National Lab., IL (USA)). Oct 1977. Contract W-31-109-ENG-38. 49p. Dep. NTIS, PC A03/MF A01.

The purpose of this study is to examine existing and future patterns of western coal movement on the Great Lakes, and to identify the potential economic and environmental impacts of significantly increased levels of western coal shipment to the lower Great Lakes region. Research needed to determine probable levels of impacts and to provide background data and guidelines for governmental and management decision-making are outlined. A total of 21 million tons per year of western coal is expected to be moved from Duluth-Superior to the lower lakes by 1985, requiring the construction of 8 to 10 new, 1000-ft, specialized coal carriers and additional lakeside coal handling facilities. The most significant impacts are anticipated to be related to noise, vessel traffic, employment, coal-storage-pile runoff, and airborne dust from coal unloading.

156 (SAND—78-8224) **Size reduction and classification of coal.** Stark, A.H. (Sandia Labs., Livermore, CA (USA)). Jul 1978. Contract EY-76-C-04-0789. 31p. Dep. NTIS, PC A03/MF A01.

We have successfully demonstrated the capability to reduce chunk coal samples by a controlled impact milling process and to classify the milled material into specific size ranges using equipment and techniques in the Sandia Livermore Powder Laboratory. We have shown that control of the mill speed is a convenient technique for maximizing the yield of material in the size range above 40 μm. Modification of the impact mill to permit lower mill speeds will be considered for future preparations. We find that air classification is far superior to mechanical sieving, despite the fact that relatively small samples of final product are desired. We have developed straightforward, rapid and systematic milling and air classification techniques which permit a narrow cut of pulverized coal, relatively free of fines, to be obtained. We have demonstrated that reproducible coal particle size distributions can be prepared with a median particle size between 10 and 100 μm. Approximately normal distributions were produced with a median size of 60 μm and 1 sigma standard deviation of approximately +-10 μm. We have demonstrated the ability to thoroughly characterize pulverized coals with regard to particle size distributions (by air sedimentation and Coulter Counter techniques), material density and specific surface areas.

157 System for drying and heating particulate coal. Offergeld, E.; Wischniewski, M. (to Buttner-Schilde-Haas AG). US Patent 4,082,498. 4 Apr 1978. Priority date 12 Mar 1975, German, Federal Republic of (F.R. Germany). 6p.

Wet particulate coal and a current of hot dry gas at superatmospheric pressure are introduced into a substantially closed drying chamber to contact the material with the gas while maintaining the drying chamber under superatmospheric pressure so that the material is dried by the gas. The dried material is withdrawn from the drying chamber and itself mixed with a stream of hot dry gas produced by burning a combustible and a combustion-supporting gas. This mixture is then reintroduced into the drying chamber as the current of hot gas used to dry the coal. The burner is operated at superatmospheric pressure and is formed of a jet-pump type injector, and a diffusor is provided downstream of this injector in the circulation path.

158 Method and apparatus for hydraulic transmission of coal, oil shale, mineral ores, etc., from the face to the surface of underground mines. Funk, E.D. (to Kamyr Inc.). US Patent 4,082,368. 4 Apr 1978. Filed date 3 Sep 1976. 16p.

A method and apparatus for hydraulically transmitting coal, oil shale, mineral ores, etc., from the mine face to the surface of underground mines via a pipeline by injecting the mined material from near the mine face into a body of water flowing in a pipeline, such injection being accomplished by an injection device which moves the mined material into the pipeline without applying any pushing forces and relocates the mined material in a continuous fashion from a first low pressure water circulation loop into a second higher pressure water circulation loop. The second water circulation loop communicates as required with a second injection device which relocates the mined material to a third higher pressure water circulation loop for increasing the pressure in the pipeline for transmission from deep mines.

159 Automatic coal haulage system in the Staszic mine, Katowice, Poland. Ferensztajn, B. (Pol Min Ind, Katowice). *Min. Eng. (London);* **137**: No. 201, 487-489(Apr 1978).

The introduction and operation of an automatic horizontal haulage system for level 720 m in this Polish underground coal mine are described. The automation of level 720 m is designed to increase the haulage capacity, reduce the work force required, and improved safety. This automation system for coal haulage comprises: (1) Remote control of the loading; (2) Unloading of the trains; and (3) Automatic train control on the line between the loading stations and the unloading station.

160 Slurry beneficiation and transportation system offers advantages for handling coking coals. Rigby, G.R.; Callcott, T.G. (BHP, Cent Res Lab, Shortland, NSW, Aust). *Aust. Min.;* **70**: No. 2, 18-20(Feb 1978).

Removal of clay coatings restores the original caking and coking properties and methods have been developed to separate and recover the coal from the slurry in a form suitable for coke oven charging. Pilot plant work has demonstrated that means can be developed to beneficiate, transport and recover coking coals for use in the steel industry. A system involving a rod or ball mill has been developed to produce a high grade coking blend product. 3 refs.

161 Investigation of the effect of geometric and operating mode characteristics of the rotor on aerodynamic and grinding performance of fan mills. Volkovinskii, V.A.; Roddatis, K.F.; Dunskii, V.D. *Teploenergetika (Moscow);* No. 1, 83-87(Jan 1978). (In Russian).

Results of an analytical and experimental investigation of the operation of fan mills on a setup are presented. The data obtained are compared with the results of industrial tests of natural-size units. The effect of the geometric characteristics of the rotor--the width, height and number of blades, as well as of the circumferential rotor velocity and pulverized fuel concentration in the stream on aerodynamic and grinding performance of fan mills is shown and a method of their calculation is presented. Application of the hydrodynamic theory of cascades to the calculation of the aerodynamic parameters of fan mill rotors is recommended. 12 refs.

COMBUSTION

REFER ALSO TO CITATION(S) 71, 104, 117, 119, 124, 125, 126, 406, 537, 538, 556, 558, 559, 560, 561, 562, 563, 564, 565, 1231, 1232, 1233, 1234

162 (APAE—2687-12) **Case study applications of venture analysis: fluidized bed. Final report.** Mosle, R. (Energy Resources Co., Inc., Cambridge, MA (USA)). May 1978. Contract EX-77-C-01-2687. 367p. Dep. NTIS, PC A16/MF A01.

In order to appraise the case for government intervention in the case of atmospheric fluid-bed combustion, Energy Resources Company and Rotan Mosle have developed a methodology containing four key elements. The first is an economic and environmental characterization of the new technology; the second, a survey of its prospective users and vendors; the third, a cost-benefit analysis of its prospective social benefits; and the fourth, an analytical model of its market penetration and the effects thereon of a basket of government incentives. Three major technical obstacles exist to continued AFBC development: feeding coal and limestone reliably to the boiler, tube erosion and corrosion, and developing boiler turndown capability. The review of the economic, environmental and technical attributes of the new technology has suggested that the preliminary venture can be selected with confidence as a commercial prospect capable of detailed evaluation from both private and public perspectives. The venture choice can therefore be considered firm: it will be the equipment required for the combustion of coal in atmospheric fluid beds as applied to industrial process steam in boilers of at least 83 Kpph capacity. The most effective demonstration of the potential of AFBC in the eyes of prospective industrial users is that provided by a project conducted by the private sector with minimal government direction. Unlike the "experimental" style of existing mixed public-private demonstration projects, the pressure to achieve reliability in more commercial applications would serve rapidly to reveal more clearly the potential of AFBC. The marketplace can be allowed to decide its fate thereafter. Once AFBC has been successfully demonstrated, the relative merits of AFBC and coal-FGD are best left to prospective users to evaluate.

163 (DOE/ET—0025/1) **Coal power and combustion. Quarterly report, January—March 1977.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). Dec 1977. Contract EX-76-C-01-2297. 81p. Dep. NTIS, PC A05/MF A01.

ERDA's coal combustion and power program has focused on two major areas: Direct combustion of coal and advanced power systems. Efforts in the area of direct combustion are concentrated on: Development of atmospheric and pressurized systems capable of burning high-sulfur coal of all rank and quality in fluidized-bed combustors; development of advanced technology power systems to generate power more economically than present technology permits while using medium- and high-sulfur coal in an environmentally-acceptable manner; development of the technology enabling coal-oil slurries to be substituted as feedstock for gas or oil-fired combustors; and improvement of the efficiency of present boilers. Compared with conventional coal-fired systems, fluidized-bed combustion systems give higher power generation efficiencies and cleaner exhaust gases, even when burning high-sulfur coals. If the fluidized-bed system is pressurized, additional economies in capital and operating costs may be realized. The benefits from high-pressure combustion are a reduction of furnace size due to decreased gas volume and better sulfur removal. High-pressure combustion, however, requires the development of equipment to clean the hot combustion products to make them suitable for use in power generation turbines. The advanced power systems program is directed toward developing electric power systems capable of operating on coal or coal-derived fuels. These systems involve the use of high temperature gas turbines burning low-Btu gas and turbine systems using inert gases and alkali metal vapors. Some 25 projects in these areas are described, including a brief summary of progress during the quarter. (LTN)

164 (EPRI-FP—806-SY) **Mixing and kinetic processes in pulverized coal combustors. Summary report.** Smoot, L.D.; Hedman, P.O. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemical Engineering). Aug 1978. 31p. Dep. NTIS, PC A03/MF A01.

An atmospheric coal combustion furnace was designed and constructed to study the effects of turbulent mixing and the kinetic processes occurring in pulverized coal furnaces. The coal furnace feeds up to 57 kg of coal per hour. The reactor was constructed in sections with one section containing several sampling probes. The probes allow for simultaneous gas-particulate sampling and are positioned in the reactor to sample both radially and axially. The use of gas and particulate tracers in conjunction with the sampling and analysis permits the determination of the local extent of mixing of primary and secondary gases, the local extent of particle dispersion, the local extent of particle reaction and the local extent of pollutant formation. The atmospheric coal furnace has been constructed, checked out, and the test data have been collected. Two additional tasks have supported the combustion testing: a pulverized coal furnace modeling development and a series of cold-flow jet mixing experiments. Two computer models have been identified. The first, a one-dimensional model which is fully developed, empirically inputs jet and recirculation mixing rates and accounts for coal pyrolysis, radiation, char oxidation, gas phase reaction, and particle-gas heat transfer effects. The one-dimensional model has been successfully applied to predict the characteristics of laboratory and industrial pulverized coal and furnaces and gasifiers. The second model is a generalized multidimensional model whose development is continuing. The cold-flow tests have investigated the mixing characteristics of particle laden, confined jets under conditions that simulate the operations of industrial pulverized coal furnaces and gasifiers but without chemical reaction. The effects of geometry and flow conditions have been investigated in 120 cold tests.

165 (FE—2437-3) **Feasibility study of using a coal/water/oil emulsion as a clean liquid fuel: Phase 2. Interim report, January—March 1977.** Dooher, J.P. (Adelphi Research Center, Inc., Garden City, NY (USA)). Apr 1977. Contract EX-76-S-01-2437. 26p. Dep. NTIS, PC A03/MF A01.

Data obtained by grinding five coals at the same setting on the Bico Pulverizer closely fitted Rossin-Rammler distributions. Using this method, the average particle size can be calculated. The particle size of the coal used has been shown to greatly influence the viscosity of the emulsion. It still appears that using a wide range of sizes in the coal makes the best emulsions, but which exact distribution has the lowest viscosity for a particular coal has yet to be determined. Atomization in burners with an air blast system has been satisfactory for coal/water/oil emulsions. With some minor adjustments, steam atomization should work. Combustion with the number 6 oil emulsion is good without pre-heating, but for the heavy oil pre-heating is necessary. Mini-explosions of the coal/water/oil drops appear violent, completely pulverizing the fuel. This should help in the combustion of this fuel.

166 (FE—2437-4) **Feasibility study of using a coal/water/oil emulsion as a clean liquid fuel. Final report.** Dooher, J.P. (Adelphi Research Center, Inc., Garden City, NY (USA)). Oct 1977. Contract EX-76-S-01-2437. 46p. Dep. NTIS, PC A04/MF A01.

The method of pulverization, as well as inherent coal structure, determines the shape of the coal particles. The shape of the coal may affect the rheological properties and the stability of the emulsion. The effect of the type of coal on the flow properties of the emulsions has been demonstrated. Besides giving different flow curves, each coal influences the stability of the emulsion as it is pumped. The effect of the shear rate on the viscosity of the emulsions has been verified. The emulsions have their highest viscosity at low shear rates and the viscosity decreases with increasing shear rate until a stable value is reached. Coal/water/oil emulsions can be pumped and burned successfully in our furnace. Efficiencies can be achieved equivalent to that of No. 2 oil. The type of coal used strongly influences the combustion properties of the emulsions. The ash deposition is easily removed and does not seem to greatly interfere with the conduction of heat in the heat exchanger. Infra-red radiation from the Illinois coal emulsion flame seems uniformly spread over the length of the flame.

167 (FE—2437-6) **Feasibility study of using a coal/water/oil emulsion as a clean liquid fuel: Phase 2, second year. Interim report, December 1977—February 1978.** Dooher, J.P. (Adelphi Research Center, Inc., Garden City, NY (USA)). Mar 1978. Contract EX-76-S-01-2437. 25p. Dep. NTIS, PC A02/MF A01.

That the particle size distribution has a major effect on the rheological properties of the emulsion was again confirmed in our work with small coal particles. When the average particle size of the PSOC 102 coal was around 65 microns, there was no trouble in making a stable 40-20-40 emulsion with a smooth flow curve. In comparison, when this emulsion is made with the fine coal, there is a layer of clear liquid immediately formed on top of the emulsion. The flow curve with its anomalous behavior at high shear rates was repeated for a majority of the emulsions in which all the liquid was not incorporated into the emulsions. It was more difficult to find an emulsion with good kinetic and static stability using the finely ground coal. The test with soda ash, which showed a reduced SO_2 level but no reduction in thermal efficiency, was a major accomplishment.

168 (HCP/T2472—27) **Fluidized-bed combustion: industrial application demonstration projects. Quarterly technical progress report, April—June 1978.** (Battelle Columbus Labs., OH (USA)). Aug 1978. Contract EX-76-C-01-2472. 76p. Dep. NTIS, PC A05/MF A01.

A subscale experimental unit has been designed and constructed and used to develop design information for a 40,000 lb/hr demonstration industrial steam generator using an advanced fluidized-bed combustion process. Nominal design for the subscale unit is a firing rate of 400 lb coal per hour and a bed cross section of approximately 2 square feet. Analysis of the heat transfer data and of erosion data has shown that the original concept of an entrained bed heat exchanger is not feasible. Consequently, the demonstration facility will employ an "external boiler" concept, wherein the entrained bed is cooled in a separate, low velocity, fluidized-bed heat exchanger. A large turndown ratio, up to 6.2 if the excess air at low levels is permitted to rise, and rapid response to step changes in firing rate as large as 50% of the full load have been demonstrated in the subscale system. Design of the demonstration facility is proceeding using the external boiler concept. Parts of this project and of the retrofit project sponsored by the State of Ohio are being combined where it is to the advantage of both. Some further experimental work will be done in the Subscale Experimental Unit System to aid in optimizing the demonstration facility design.

169 **Modified starch containing liquid fuel slurry.** Metzger, G.W. (to Carbonoyl Co.). US Patent 4,082,516. 4 Apr 1978. Filed date 26 Nov 1976. 4p.

A substantially water-free, high solids content, stably dispersed combustible fuel slurry is provided, with a method of preparing the slurry. The slurry contains a minor amount of a solid particulate carbonaceous material such as powdered coal, with substantially the entire balance of the slurry being comprised of a liquid hydrocarbon fuel, particularly a heavy fuel oil. In extremely minor amounts are anionic surfactants, particularly soaps, and a stabilizing amount of a starch modified with an anionic polymer.

170 **Effect of devolatilization on nitric oxide formation from coal nitrogen.** Vogt, R.A.; Laurendeau, N.M. (Purdue Univ, Sch of Eng, West Lafayette, Indiana). *Fuel;* **57**: No. 4, 232-234(Apr 1978).

A simple heuristic model is proposed to explain the effect of devolatilization on both coal nitrogen conversion and NO formation. 17 refs.

171 **Attack on the problem of coal washery waste.** *Queensl. Gov. Min. J.;* **78**: No. 909, 337-338(Jul 1977).

A brief account is given of a fluidized-bed combustion pilot plant under construction at Glenlee coal preparation plant, Camden, NSW. The plant, which is based on experimental work at CSIRO, will burn washery waste.

MARKETING AND ECONOMICS

172 (CONF-780553—1) **Role of synthetics in future gas supply.** Schora, F.C. (Institute of Gas Technology, Chicago, IL (USA)). 1978. 10p. Institute of Gas Technology, Chicago, IL.

From American Gas Association Transmission conference; Montreal, Canada (8 May 1978).

The gas industry has been developing technologies for the conversion of fossil and renewable fuel to SNG. Lurgi and Kopper-Totzek processes are considered first-generation or commercial realities and the newer technologies under development are termed second-generation. Less-developed processes or concepts, now under consideration have recently been termed third-generation technology. HYGAS appears at present a likely candidate for early demonstration using commercial-size equipment. The HYGAS pilot plant has been operating since 1971 and has handled all U.S. coal types including lignites, subbituminous coal, and highly caking bituminous coals. The CO_2 Acceptor plant program has been completed with the pilot plant mothballed and no present prospects for demonstration. The BIGAS pilot plant is still in the initial startup phase. The Synthane Process, a totally Government-support effort, is in the initial operational phases and may be phased out in the not-too-distant future. It is possible that the Synthane pilot plant will be used for the development of a catalytic-induced gasification process now at the laboratory stage of development. Two additional processes—COGAS and the slagging gasifier (both relative newcomers)—are also at present under consideration for demonstration by the U.S. in addition to HYGAS. The COGAS Process, a process which co-produces both a synthetic crude and a gaseous fuel, is now under intensive development in Leatherhead, England, where the gasification portion of the system is being developed. The liquid portion of the system, the COED Process, had previously been piloted in Princeton, New Jersey.

173 (DOE/EIA—0003) **Coal situation monitoring system: baseline report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 2 Dec 1977. 46p. Dep. NTIS, PC A03/MF A01.

The contract between the United Mine Workers of America and the Bituminous Coal Operators Association and the Western Surface Mine Wage Agreement expired December 6, 1977. Coal stock levels maintained by utilities and industry and the future rate of consumption and non-WMWA production will largely determine the impact of a strike on these sectors. Estimates for average days supply of coal on December 6, 1977 varied from six weeks to nearly three months. Due to more-limited stocks, the general (non-utility) industry was expcted to hit first and hardest by a lengthy coal strike. Industrial consumers would be affected sometime before eight weeks, with production cutbacks and layoffs. The severity of the impact would depend upon the availability of supplies from residual production. The states (on the basis of available data on stock, consumption rates, and dependence on UMWA-controlled coal) that appeared to be most vulnerable to a strike are listed.

174 **Keeping it simple: a case study in corporate planning.** Sedgwick, A. (Natl Coal Board). *Long Range Plann.;* **11**: No. 1, 10-14(Feb 1978).

This paper makes a major point about the nature of corporate planning by considering the question of investment in the production capacity of the British coal industry. 3 refs.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 1575

175 **Training to cover all the bases.** Kraft, B. (Natl Coal Assoc). *Coal Min. Process.;* **15**: No. 5, 50-53(May 1978).

An extensive series of training programs for coal miners, developed and offered for sale in a joint effort by the National Coal Association (NCA) and Bituminous Coal Operators' Association (BCOA), is briefly described here. These training programs, now available on an industry-wide basis, are geared to specific job skills in the mines, supervision designed for coal mine foremen, and health and safety procedures that will satisfy federally mandated training.

176 **Health in coal mines.** Amoudru, C. (Charbonnages de Fr). *Colliery Guardian;* **226**: No. 3, 164, 167-168(Mar 1978).

The author briefly looks at the past health conditions in coal mines, and then focuses on the current advances in miners' health, which are due not only to purely medical measures but also to the progressive phase out of the percussive rock drill and, in a more general way, to technological improvements and increased living standards. Special emphasis is placed on pulmonary diseases and their treatment. Other than respiratory risks are also examined.

177 **Pneumoconiosis of the coal miner: epidemiological data.** Amoudru, C. (Charbon de Fr). *Ann. Mines;* **184**: No. 1-2, 59-62(Jan-Feb 1978). (In French).

Pneumoconiosis of the coal miner is one of the world's most serious and widespread occupational diseases. The author presents the statistical data on the number of French coal miners, both working and retired, who are affected by pneumoconiosis, and then emphasizes the improvements in industrial-hygiene practices in mines, which led to a decrease in new medical cases per year from 2.4% in 1957 to 0.8% in 1977, with considerable differences between one coal basin and other. 4 refs.

178 **Activity of the Institute for Mine Health during the year 1976.** Degueldre, G. (Inst d'Hyg des Mines, Hasselt, Belg). *Ann. Mines Belg.;* No. 12, 1139-1176(Dec 1977). (In French and Flemish).

This report reviews the Institute's 1976 activities which are subdivided into two main groups, the first one dealing with the work of the Medical Division, and the second focusing on the work done by the Technical Division. The Medical Divison conducted research work covering the cause of bronchitis in coal miners, high-temperature problems that plague these miners, and radiological diagnosis of pneumoconiosis. The Technical Division performed gravimetric and other tests to analyze mine dust, improved the dust abatement procedures, established the characteristics of ventilation circuit, and made advances in the application of process control to the ventilation in mines. 10 refs.

179 **Rescue drill in tests at Springfield.** *Coal, Gold Base Miner. South. Afr.;* **25**: No. 7, 68,73(Jul 1977).

Equipment suitable for drilling rescue holes from the surface has been developed by Ingersoll-Rand for the Chamber of Mines of South Africa. It is designed to penetrate 250 m and in tests in hard dolerite has achieved a drilling rate of 3.7 m/h.

180 **Rescue Coordination Centre, Institute for Safety and Rescue, Hasselt: report for the year 1976.** Mayne, J.; Sikivie, A. *Ann. Mines Belg.;* 590-625(Jun 1977). (In French and Dutch).

1976 saw the beginning of two new activities: the organization of the training and formation of a rescue team in Liege as well as the other aspects of linking the mines of Argenteau and Cheratte to the rescue center in Hasselt; and preparation for the introduction of self-rescuer filters in the mines of the Kempten. The traditional activities include the training and formation of rescue teams in the Kempen and the promotion of safety. In collaboration with Kempense Steenkolenmijnen, the University of Louvain and other institutes have been working on thermal restrictions and constraints. Other activities are described, including gas analysis and maintenance of respirators.

181 (NP-tr—2031) **Thermal conductivity of carboniferous rocks and its influence on mine climate.** Muecke, G. Translated from *Bergbau-Arch.;* **25**: 35-58(Feb 1964). 66p. British Library Lending Div., Yorkshire, Eng.

The general Fourier law states that the heat flow transferred from the rock to the mine opening is proportional to the temperature gradients and the coefficient of thermal conductivity of the surrounding rock. The thermal constants of carboniferous rocks were examined by a so-called stationary absolute method. The necessary rock samples were drilled with a coring machine in 85 stone horizons of the productive carboniferous strata. The measurements gave coefficients of thermal conductivity between 2.7 and 3.9 kcal/m x h x degrees for sandstone, with an average from 52 stone samples of 3.3 kcal/m x h x degrees. With mudstone, the average of 28 rocks was a coefficient of 2.5 kcal/m x h x degrees with a scatter of +-10%. Regarding the influence of temperature, the relationship in sandstone was found to be linear with a reduction—of little technical importance—of about 0.25%/degree in the thermal conductivity, while in the case of mudstone the influence lay within the range of accuracy. With sandstone of high porosity, the thermal conductivity is increased by absorption of water by at least 20%; in sandy shale and mudstone the influence is insignificant owing to the low water absorption. The heat transmitted by convection usually forms only a small part of the total heat transmitted. In the overwhelming majority of cases, the enthalpy increase of the mine air by a rise in the latent heat is due to water evaporation; the additional evaporation heat being supplied by the rock. By using the thermal coefficients obtained for calculating the heat flow in the rock surrounding the airways, combined with the theoretical temperature gradient, a technically satisfactory agreement can be reached for roadways, whereas in faces the actual rock heat flow is greater than the calculated figure.

REGULATIONS

REFER ALSO TO CITATION(S) 144

182 (DOE/ER—0012) **Summary of meetings on university coal laboratories.** (Department of Energy, Washington, DC (USA). Office of Energy Research). Aug 1978. 38p. Dep. NTIS, PC A03/MF A01.

The Surface Mining Control and Reclamation Act of 1977, signed by the President on August 3, 1977, authorized the designation of 10 university coal research laboratories (UCL's). As a prelude to the establishment of criteria for selection, and to the preparation of guidelines for submission of proposals, a series of public information meetings were held in order that comments from parties interested in the designation and operation of the UCL's could be obtained. This report summarizes the results of those meetings.

183 **Rehabilitation of mined areas.** Hannan, J.C. *Aust. Min.;* **70**: No. 2, 34-45(Feb 1978).

This paper deals with rehabilitation requirements and methods which relate to open-cut coal mines and large-scale strip-mines in New South Wales.

PETROLEUM

REFER ALSO TO CITATION(S) 858

RESERVES

REFER ALSO TO CITATION(S) 487

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 257

184 **Mathematical models for petroleum-forming processes: carbon isotope fractionation.** Waples, D.W. (Colorado School of Mines, Golden (USA)); Tornheim, L. *Geochim. Cosmochim. Acta;* **42**: No. 5, 467-472(May 1978).

A mathematical model has been developed in which carbon isotope fractionation during thermal cracking of n-paraffins can be simulated. The model has been calibrated based on data from laboratory cracking experiments carried out on n-octadecane. Relative rate constants for cleavage of ^{12}C-^{12}C, ^{12}C-^{13}C and ^{13}C-^{13}C bonds agree with the experimental values obtained by other workers. Application of this model to the process of petroleum formation gives good agreement with some existing experimental data, but suggests that a review of our understanding of isotope fractionation during thermal cracking may be necessary. The relative importance of the degree to which the organic material has been cracked and of the type of the organic material in influencing delta^{13}C values is discussed. The present model predicts that cracking of n-paraffin distributions having initial odd or even carbon number predominances can induce isotopic inhomogeneity among the homologs of the resulting distribution. The model exhibits some deficiencies in explaining or predicting the delta^{13}C values of ethane and propane in relation to methane in gases, and of oils and associated methane. Explanations for these discrepancies may lie in the simplicity of our mathematical model, in our assumption of initial isotopic homogeneity within molecules, and in our use of only n-paraffins as the source molecules for the cracking reactions.

185 **Deeper exploration at Elk Hills.** Rintoul, B. *Pet. Eng.;* **50**: No. 3, 94, 99, 102(Mar 1978).

In 59 years since the original discovery, drillers have found an estimated billion bbl of reserves in California's Elk Hills field, 16 miles southwest of Bakersfield, Calif. This article describes a deeper pool exploratory drilling program which is now being conducted by the Department of Energy to determine if there is more oil at depth. Prime targets for the deeper pool exploration are the Phacoides sand of early Miocene age, the Oceanic sand of Oligocene age and the Point of Rocks sands of late Eocene age. All are productive in nearby fields at depths no greater than 10,500 ft, but have not been penetrated at Elk Hills.

186 **Trapping of heavy oil at Lloydminster.** Vigrass, L.W. (Univ of Regina, Sask). *J. Can. Pet. Technol.;* **17**: No. 1, 35-42(Jan-Mar 1978).

Most of the oil in the Lloydminster area in Canada occurs in the Sparky and General Petroleums (G.P.) sandstones. These sandstones are widespread tabular sheets which are probably marine delta-front deposits over much of the area. Detailed studies show that the bulk of the Sparky and G.P. oil is trapped downdip from gullies or channels that are filled with upper Mannville shaly rocks. Recognition of the presence and nature of the disconformity is extremely important in exploration, in development, and in evaluating heavy oil resources for enhanced recovery. 4 refs.

187 **Improved reservoir description: Swan Hills Unit No. 1.** Sears, J.R. (Home Oil Co Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **17**: No. 1, 43-50(Jan-Mar 1978).

Oil production in the Swan Hills A and B Pools in Canada is taken from the Swan Hills Formation of the Beaverhill Lake Group of Devonian age. The reservoir rock is a carbonate formed in a bioherm. The rock mass is rather complex, with at least seven major porous zones having been identified. The reservoir description used in the early engineering studies was rather simple and bore scant resemblance to the complex reservoir geology. As the waterflooding operation has become more mature, it has been necessary to use increasingly more complex geologic models in order to reconcile reservoir performance prediction with observed reservoir performance data. 3 refs.

188 **Lower Cretaceous geology and heavy oil potential of the Lloydminster area.** Orr, R.D.; Johnson, J.R.; Manko, E.M. (Husky Oil Ltd, Calgary, Alberta). *J. Can. Pet. Technol.;* **17**: No. 1, 73-89(Jan-Mar 1978).

This article outlines the Lower Cretaceous Mannville depositional framework, illustrates selected depositional environments and describes an oil-in-place assessment for the area. The Mannville sands of the Lloydminster area contain more than 16 billion barrels of oil-in-place. The reservoirs that have demonstrated primary production and were included in this estimate comprise the Colony, McLaren, Waseca, Sparky, GP, Lloydminster and Cummings sands. The Sparky is the most prolific producer. The Cummings and Colony units have been minor contributors to date. 10 refs.

189 **Automatic kriging and contouring in the presence of trends (universal kriging made simple).** Davis, M.W.D.; David, M. (Ec Polytech, Montreal, Que). *J. Can. Pet. Technol.;* **17**: No. 1, 90-99(Jan-Mar 1978).

This article presents a new automatic interpolation and contouring technique which automatically recognizes the spatial structure of the data to be contoured even when trends are present and data are not regularly spaced. A brief review of contouring problems is presented, the idea of spatial structure and its characterization by a generalized covariance is then introduced, and the POLYPAC program is described. Applications in various areas (oil shales, sulfide mines, coal fields, cement industry, geophysical data) are illustrated and a detailed appendix covers the mathematical theory of the intrinsic random functions of order k, which is the basis for the program. 14 refs.

190 **Improvement in seismic survey and increasing the effectiveness of preparing structures for exploratory drilling in Bashiriya.** Kukharenko, Yu.N.; Khat'yanov, F.I.; Yunusov, N.K. *Geol. Nefti Gaza;* No. 7, 1-6(Jul 1977). (In Russian).

An examination is made of seismic operations and specific examples of the effectiveness of using the reflecting horizon method for identifying complexly constructed oil and gas traps which are controlled by horst, graben-like, and low-amplitude anticline structures as well as those of reef origin. The exploratory criteria and factors which influence the quality and degree of geological information of reflecting horizon method time profiles have been established. Ways have been outlined for improving exploratory-survey operations under the complex seismo-geological conditions of the Russian platform's southeastern slope and the Pre-Urals deflection. 3 illustrations, 3 references.

191 **Complex geophysical study of reefs in the L'vov paleozoic trough.** Fil'shtinskii, L.E.; Boiko, A.I.; Buderkevich, M.D.; Kobrin, R.M. *Geol. Nefti Gaza;* No. 7, 6-12(Jul 1977). (In Russian).

Studies of the Buchach area by the reflecting horizon method, vertical electric logging, and large-scale gravimetry indicate the presence of an extensive sidewall zone of incompletely compensated deflections in the late Silurian period. A stratified zonality of absorption anomalies, rate, density, and electrical resistance is associated with adjoining, raised sectors. Forecasts are made for areas having an increased barrier reef width, and those areas are associated with consedimentationally developing cover structures. 4 illustrations, 4 references.

192 **Positioning of wells when searching for oil and gas deposits in low-amplitude upheavals.** Lebed, V.P. *Geol. Nefti Gaza;* No. 7, 13-15(Jul 1977). (In Russian).

A method was worked out for placing primary wells in searching for oil and gas in low-amplitude upheavals. The initial well should be drilled in the axial cross-sectional point and the second, subordinate well, should be drilled in the upheaval limb at the cross-section of the last closed isoline and the fold's axis. If collectors are absent in the trap's anticline, the next well should be drilled on the paleo-anticline in order to search for a lithologically screened deposit. 1 illustration, 6 references.

193 Problems and criteria for the quantitative forecasting of oil and gas content in pourly studied regions. Nalivkin, V.D.; Lazarev, V.S.; Belonin, M.D.; Svercnkov, G.P. *Geol. Nefti Gaza;* No. 7, 19-23(Jul 1977). (In Russian).

An enumeration is made of problems of forecasting which can be solved at the contemporary level of knowledge. The requirements for quantitative forecasting indices are formulated as well as their requirements for variably sized sites. The reliability, accuracy and degree of detail in the forecasts should be indicated. It is concluded that at the contemporary stage of oil and gas content forecasting, one should not exclude the use of improved methods of expert evaluations which are controlled by other methods. 1 table, 5 references.

194 Seismographic exploration possibilities in surveying non-anticline oil and gas deposits. Rapoport, M.B. *Geol. Nefti Gaza;* No. 7, 23-28(Jul 1977). (In Russian).

The problem of finding hydrocarbon accumulations by associated changes in a seismic wave field is examined. Testing examples are cited in various areas in which the direct search correlation method was used. The anomalous zones were found to be associated with aureoles accompanying oil and gas deposits. 4 illustrations, 11 references.

195 Hydrodynamic well research methods of obtaining greater detail of the Raevskii field geological structure. Lozin, E.V.; Polyakova, V.K.; Borovkova, T.G. *Geol. Nefti Gaza;* No. 7, 33-37(Jul 1977). (In Russian).

Maps for a seam's permeability, piezo- and hydroconductivity were constructed by using geological-industrial data obtained by hydraulic monitoring and "self-monitoring" of a seam well D_1 in the Raevskii Field and by studying wells by established samplings. Detailed information was obtained on the geological structure of deposits in the zone of the sublatitudinal "feathering" fault in the north and in the crown section of the deposit. Recommendations are made for improving flooding. 3 illustrations, 2 references.

196 Evaluation of gas condensate oil type deposits by determining the critical composition and temperature of the Stratal system. Razamat, M.S. *Geol. Nefti Gaza;* No. 7, 37-41(Jul 1977). (In Russian).

Until the present time there has not been a rigidly substantiated distinction between oil fields with a gas cap and gas condensate fields with an oil fringe. Basic consideration is given to economic factors in the operation of oil or gas sections of the deposit. The deposit type can be evaluated on the basis of the stratal system's critical temperature (composition). An equation obtained on the basis of experiments with various oils is suggested for calculating the critical temperature (composition). 2 tables, 2 illustrations, 7 references.

197 Hydrogeological conditions of the Srednekurinskaya depression in the Mesozoic period. Rustamov, R.I. *Geol. Nefti Gaza;* No. 7, 41-46(Jul 1977). (In Russian).

An identification is made of the Jurassic, upper Cretaceous, and lower Cretaceous hydrogeological cycles and an examination is made of their elision and infiltration stages. The first stages were shown to be lengthy ones and the last were of a short time duration. Gas and oil formation and gas and oil accumulation in the Srednekurinskaya depression are associated with elision stages of hydrogeological history. Subsequently, an evaluation is made of prospective oil and gas content in Mesozoic deposits. 1 illustration, 11 references.

198 Comparison of aromatic petroleum hydrocarbons and organic matter from Mesozoic-Cenozoic deposits of the pre-caucacus. Botneva, T.A.; Nechaeva, O.L. *Geol. Nefti Gaza;* No. 7, 46-50(Jul 1977). (In Russian).

Identical polycyclic aromatic hydrocarbons are found in oils and chloroform bitumens of Mesozoic-Cenozoic deposits. A study of the latter indicates genetic properties common to the oils and organic matter and makes it possible to hypothesize that the basic mass of oils have been generated by the deposits in which they are embedded. 4 illustrations, 10 references.

199 Compaction of carbonate deposits and the paleohydrodynamics of stratal waters. Il'in, V.D.; Spevak, Yu.A.; Malkin, S.P.; Eivazov, A.M. *Geol. Nefti Gaza;* No. 7, 55-59(Jul 1977). (In Russian).

An examination is made of the method of studying the compaction of carbonate rocks and of quantitatively evaluating water expressed from clay components as illustrated by the upper Jurassic carbonate complex of the Amudar'inskaya syneclise and adjoining regions. These studies make it possible to identify the basic direction of sedimentation water run-off, the migration paths of hydrocarbons and their accumulation zones. 2 tables, 2 illustrations, 7 references.

200 Strategy and tactics of oil exploration. Sozanskii, V.I. *Geol. Nefti Gaza;* No. 7, 62-69(Jul 1977). (In Russian).

The modern rapid rate of oil production requires new sites for oil exploration which are suggested to include eroded shelves of a crystalline foundation and wide deep decondensation zones of a crystalline crust. 3 illustrations, 14 titles.

201 Analysis of successes in exploration borehole drilling for oil and gas in the USA. Kurov, A.V. *Geol. Nefti Gaza;* No. 7, 69-73(Jul 1977). (In Russian).

An analysis is made of the degree of success (in the form of reserve increment per one borehole or 1 meter of shaft sinking) for individual categories of boreholes and for stages of operations. Changes in successful exploration over recent years are indicated. 5 tables, 2 references.

202 Separation of carbonate reservoirs and studies of their filtration capacity using neutron methods. Litvinov, B.N.; Rezvanov, R.A.; Krivko, N.N. (Moskovskii Inst. Neftekhimicheskoi i Gazovoi Promyshlennosti (USSR)). *Razved. Geofiz.;* No. 73, 116-123(1976). (In Russian).

The temporal study technique of carbonate deposits is described using neutron methods aimed at finding the filtration-volumetric properties of collectors. The results of borehole explorations enable one to classify the collecting beds into the groups with identical filtration properties, to establish the time during which the drilling solution filtrate penetration zone is disembodied, and to estimate the lower limit of the collector porosity.

203 Combination of well logging techniques to study geological sequences of oil and gas well. Zefirov, N.N.; Kamenev, S.P.; Kuleshova, G.K.; Chukin, V.T. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Geofizicheskikh Metodov Razvedki, Moscow (USSR)). *Prikl. Geofiz.;* No. 82, 178-191(1976). (In Russian).

Principles for complexing geophysical studies of oil and gas boreholes are outlined. Substantiation is provided for typical complexes of geophysical studies applied to various geological and engineering drilling conditions. Typical complexes and a list of corresponding multi-purpose borehole-mounted equipment are given. Within the complex of geophysical studies special consideration is given to the following nuclear-geophysical methods: gamma-gamma logging, neutron logging, nuclear-magnetic logging, pulsed neutron-neutron logging, gamma logging.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 186, 187, 189, 859, 1170, 1243

204 (BERC/TPR—78/4) Mud pulse logging while drilling telemetry system: design, development, and demonstrations. Spinnler, R.F.; Stone, F.A. (Teleco Oilfield Services, Inc., Middletown, CT (USA)). Jul 1978. Contract ET-76-C-03-1817. 22p. Dep. NTIS, PC A02/MF A01.

From 1978 drilling technology conference of the International Association of Drilling Contractors, Houston, TX, USA, 7 Mar 1978.

Mud pulse telemetry is a method of transmitting information from the vicinity of the drill bit to the surface drilling platform while drilling. Information can be conveyed through a flowing column of drilling mud by the presence or absence of pressure pulses arranged in a binary code. Pressure in the flowing mud column is periodically modulated at a point downhole by mechanical means, and the resulting periodic pressure pulses appearing at the surface end of the mud column are detected by a pressure transducer conveniently located in the standpipe. Although the concept of mud-pulse telemetry is not new, only recently have sophisticated systems embodying mud-powered turbine generators and solid-state electronics been developed to the point of being able to withstand the hostile downhole environment. After ten years of active technology development and over $10 million of R and D expenditures, Teleco has demonstrated through field tests carried out in the Gulf of Mexico during 1977, that equipment reliability necessary for commercial operation is essentially at hand. Three generations of prototype systems were tested under actual drilling conditions during 1968 through 1977. Using eight new production systems, Teleco began a Pilot Service Demonstration in August 1977, under a contract with the U.S. Department of Energy and six major oil companies. Each system consisting of a sensor assembly and mud pulse telemetry transmitter measures borehole azimuth, inclination, and tool facing. Accurate directional measurements have been provided from kick-off through to target depth with minimum interruption to the drilling operation. Tool face information has been used to successfully kick-off directional wells using both mud motor and jet deflection techniques. Equipment reliability, as indicated by recent test runs of 254 and 272 hours of drilling with two separate systems, without failure, is approaching the level needed for commercial service.

205 (CONF-780825—P1) Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Volume 1A. Oil. Linville, B. (ed.). (Department of Energy, Bartlesville, OK

(USA). Bartlesville Energy Technology Center). 1978. 445p. Dep. NTIS, PC A19/MF A01.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

Contains papers of the following sessions: Session A. Micellar-polymer flooding; Session B. Improved waterflooding.

Papers on micellar-polymer flooding and improved waterflooding were compiled in Volume XX 1A. Individual abstracts were prepared for inclusion in the EDB data base.

206 (CONF-780825—P1, pp A1.1-A1.24) **North Burbank Tertiary Recovery Pilot Test. Third year status report.** Kleinschmidt, R.F.; Trantham, J.C.; Sitton, D.M.; Dickinson, W.R. (Phillips Petroleum Co., Bartlesville, OK). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The Phillips/DOE tertiary pilot test, which was initiated in May 1975 in a 90-acre portion of Tract 97 of the North Burbank Unit, has proceeded beyond the injection of the surfactant and polymer chemicals and been returned to drive water injection. Phillips is the operator for 18 working interest owners. The injection of the tapered polymer slug was completed in January 1978 and the injection of fresh water was begun. The final concentration of polyacrylamide during the last 75 days of injection was about 100 ppM. Monitoring of the produced fluids was continued for the appearance of surfactant, alcohol, polymer and various inorganic ions. Oil production continued to increase into the fall of 1977 when it leveled out at about 220-230 B/D. The predicted baseline from waterflood operations alone was 56 B/D. The program to increase the pilot fluid rates via stepwise increases in injection rates was resumed in March 1978. Certain producing wells were stimulated by fracturing. Injection pressures were monitored for evidence that injection rates were being kept within limits which would avoid appreciable extension of the fractures, since such extensions would tend to promote mixing of chemicals with formation water and/or less of fluids outside the pattern. Preliminary results of these operational changes will be reported.

207 (CONF-780825—P1, pp A2.1-A2.20) **Micellar-polymer oil recovery demonstration in the Bell Creek Field, Montana.** Goldburg, A.; Haddenhorst, F.; Johnson, G.; Stevens, P. (Gary Operating Co., Englewood, CO). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Gary Operating Company is conducting a DOE Pilot Demonstration to determine whether micellar-polymer waterflooding is an economically feasible technique for enhanced oil recovery at the Bell Creek Field, Powder River County, in southeastern Montana. The pilot is a contained 40-acre 5-spot embedded in a representative watered-out portion of the field. The net pay is sandstone with average properties: thickness, 8 feet, porosity, 29%, permeability (air), 1050 md, and water TDS of 4000 ppM. The pilot area interwell oil saturation after waterflood available for tertiary recovery is presently evaluated at 35%; and the overall micellar-polymer recovery is estimated at 54%. During the second contract year (July 1977 to July 1978), site development included: pressure pulse testing to show continuity, to obtain absolute permeability values and observe directional permeability trends; log-inject-log tests on injection wells MPP-1 and MPP-3 to gain an estimation of the ultimate residual oil saturation after the waterflood; a tracer survey to better define reservoir parameters in the pilot area; numerical simulation using the results of the other tests for a final determination of an inter-well average value of the residual oil saturation in the pilot area. Other major efforts for the year included: injection plant and fluid distribution facilities design, construction, development and testing; acquisition of chemicals through standard bid procedures and contract execution; design and construction of a field analytical laboratory and acquisition of analytical equipment; and initiation of production monitoring efforts.

208 (CONF-780825—P1, pp A3.1-A3.20) **Commercial scale demonstration of the Maraflood process: M-1 Project, Crawford County, Illinois (1977—1978).** Burdge, D.N. (Marathon Oil Co., Houston, TX). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

The contract for this commercial scale demonstration of the Maraflood/sup TM/ oil recovery process was executed between the Department of Energy and Marathon Oil Company on September 30, 1976. Injection of micellar solution was initiated on February 10, 1977. Micellar solution injection in this 407 acre project has now been underway for 18 months. It remained routine at the design rate for the first ten months. At that time the rate had to be reduced significantly because of the restricted availability of a chemical used in micellar solution manufacture. The resolution of this problem is discussed. Operations have been otherwise routine during the past year. Fluid production history is reported. No unusual or unpredicted production response has been experienced. The results of performance monitoring including transient testing, produced fluid analyses and observation well logging are summarized.

209 (CONF-780825—P1, pp A4.1-A4.22) **Micellar-Polymer Joint Demonstration Project, Wilmington Field, California.** Staub, H.L. (Dept. of Oil Properties, Long Beach, CA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

A contract was signed to conduct jointly a Micellar-Polymer Project which would establish a tertiary oil recovery technique applicable to unconsolidated oil sands typical of the California Coastal Province. This project is an application of the Maraflood (TM) Process with technical assistance being provided by Marathon Oil Company. After conducting numerous computer model studies, the test pattern selected is a staggered-line drive consisting of four injection wells and six producing wells with the line of injectors backed-up by a north-south trending fault. This pattern comprises about 11 acres with an average net sand thickness of 52 feet. Laboratory studies have been performed by Marathon Research Center to determine the most efficient slug for oil displacement and to determine the best polymer concentration and type for mobility control. The laboratory floods have been conducted using reservoir core material in radial disk floods under confining pressures of 1400 psi and reservoir temperature. A mini-injectivity test was performed in well FT-1 in which an 850-barrel sulfonate slug was injected followed by several types of mobility buffer polymers at varyng concentrations and volumes. This test was performed to demonstrate that a sulfonate system and various concentrations of mobility buffer polymers could be injected at acceptable rates and pressures. Surface facilities for the project have been installed, portions of which were utilized for the mini-test, and only minor improvement alterations are required. The drilling program is completed. Four injection wells and six producing wells were drilled and three of these wells were cored. Suites of electric logs were run to supplement the core data for determination of reservoir characteristics.

210 (CONF-780825—P1, pp A5.1-A5.15) **Big Muddy low-tension flood process demonstration project.** Ferrell, H.H. (Continental Oil Co., Ponca City, OK); Davis, J.G. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Continental Oil Company will conduct a low-tension flood demonstration project in the Big Muddy field near Casper, Wyoming. Since Big Muddy is similar to many reservoirs in the Rocky Mountain Region, a successful project will also provide the economic feasibility of the process for many reservoirs in eastern Colorado, Wyoming and Montana. The Rocky Mountain reservoirs pose problems with low matrix permeability and jointing which in many cases leads to fracturing at pressures lower than hydrostatic. Offsetting these disadvantages is the low hardness, low salinity reservoir water. The reservoir properties and Continental's design philosophy are discussed.

211 (CONF-780825—P1, pp A6.1-A6.15) **National benefits/costs of enhanced oil recovery research.** Korn, D.H. (Arthur D. Little, Inc., Cambridge, MA); Rothermel, T.W.; Mansvelt-Beck, F.; Calvert, M.G.; Perry, C.W. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

The Department of Energy's (DOE) enhanced oil recovery (EOR) program has been studied from the standpoint of national benefits and costs. DOE's expenditures on research, development, and demonstration (RD and D) of technology constitute a set of public costs, for which there are expected returns in the form of public benefits. Six types of benefits associated with an EOR research program were identified: (A) National Savings from an EOR Option, (B) Avoiding the Cost of Re-Entry of Oil Fields, (C) Balance of Payments Value (D) Value as Part of an Emergency Stockpile, (E) Insurance and Portfolio Values, (F) General Societal Benefits. They may be defined, grouped, and evaluated in a rational manner to assist in public policy and decision-making. Types A, B, and C are more readily quantified in dollar terms. The other types of benefits are not easily quantified, but are important considerations and are discussed. The emphasis in the analysis was placed on the quantification of the dollar benefits, i.e., the savings to be realized by the Nation as a result of the probability of having some cheaper

supplementary oil available from accelerated EOR research than would be otherwise available under uncertain alternative futures. Savings were defined as the differential in total cost for a given supply of oil between a scenario that assumes no Federal support of EOR-related RD and D and a scenario that assumes significant Federal RD and D support. The benefits and costs were discounted to present value, using a range of discount rates. The indications from this analysis are that the benefits of national investment in EOR research generally outweigh the costs; and, in terms of the quantifiable benefits and costs that benefit/cost ratios exceed unity. EOR continues to promise sufficient rewards in domestic oil supply and energy cost savings to justify an accelerated Federal research, development and demonstration program.

212 (CONF-780825—P1, pp A7.1-A7.10) **Chemical flooding research at the University of Texas.** Thach, S.; Hayes, M.; Bourrel, M.; Wade, W.; Schechter, R. (Univ. of Texas, Austin). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

The work at the University of Texas includes adsorption, phase behavior and interfacial studies. A variety of surfactants including prime candidates for oil recovery have been studied. This brief report focuses on the studies of nonionic surfactants. Adsorption isotherms are seen to exhibit three regions with a sharp increase in adsorption occurring at small concentrations. An adsorption plateau is found near the CMC. A second thrust has been a systematic study of the interfacial tension of selected nonionics. This work is well underway. Rules for predicting the molecule structure best suited for a particular system have been developed. Phase behavior studies have been indicated that temperature behavior with nonionics parallels the salinity behavior observed with anionics. Studies to determine the effect of alcohols and the average number of ethylene oxide groups have been conducted.

213 (CONF-780825—P1, pp A8.1-A8.8) **Structure of aqueous solutions and microemulsions containing petroleum sulfonates.** Benton, W.J.; Hwan, R.; Natoli, J.; Miller, C.A.; Fort, T. Jr. (Carnegie-Mellon Univ., Pittsburgh). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

The polarizing microscope has been used to study liquid crystalline structures in aqueous surfactant phases. Different structures were found in different ranges of surfactant and salt concentration. A mixture of two structures was found to be characteristic of solutions which formed a surfactant (or middle) phase on addition of a particular refined oil mixture. The ultracentrifuge was used to study various microemulsions in systems of two synthetic petroleum sulfonate surfactants. Drop sizes were determined for water-continuous (lower phase) and oil-continuous (upper phase) microemulsions. The surfactant phase was found to be water-continuous in the low salinity portion of its range of existence and oil-continuous in the high salinity portion. These results are consistent with the mechanisms proposed previously for formation of the surfactant phase and for the origin of ultralow interfacial tensions.

214 (CONF-780825—P1, pp A9.1-A9.16) **Mechanism of ultralow interfacial tension in surfactant flooding. Phase and tension behavior of sulfonate surfactant systems.** Franses, E.I.; Puig, J.E.; Talmon, Y.; Miller, W.G.; Scriven, L.E.; Davis, H.T. (Univ. of Minnesota, Minneapolis). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

Parallel studies of pure sodium-8-phenyl-n-hexadecyl-p-sulfonate and the petroleum sulfonate TRS 10 to 80 in aqueous sodium chloride and in decane have been made by spinning drop tensiometry, spectroturbidimetry, conductimetry, ultrafiltration, ultracentrifugation, vapor sorption, nuclear magnetic resonance spectroscopy, polarizing light microscopy, and newly developed fast-freeze, cold-stage techniques for transmission electron microscopy by which microstructures can be visualized. The pure surfactant is soluble in water to only 0.06 wt% at 25°C, 11-fold more at 90°C, but 300-fold less in 3 wt% salt in 25°C. Excess surfactant ranges in state from visibly settling particulate suspensions to transparent, stable dispersions of submicroscopic particles. Surfactant solubility in decane is 0.04 wt% at 25°C and about 9 wt% at 50°C, an excess surfactant appears to form a birefringent phase. About 20 wt% decane is vapor sorbed by dry surfactant at 25°C. Preliminary results reveal liquid crystalline states in surfactant-decane-brine systems. Interfacial tensions of aqueous saline solutions and suspensions of the pure surfactant against decane relate directly to phase behavior. Changing the order of mixing 0.07 wt% surfactant and 0.3 wt% NaCl in water affects strongly the transient and steady tensions against decane, and alters the state of dispersion of the liquid crystal present. This dispersed surfactant and not dissolved surfactant appears responsible for ultralow tensions. Results with the practical surfactant TRS 10 to 18 support this conclusion, which has important implications for surfactant flooding.

215 (CONF-780825—P1, pp A10.1-A10.6) **Large-scale samples of sulfonates for laboratory studies in tertiary oil recovery: preparation and related studies.** Malmberg, E.W. (Suntech, Inc., Richardson, TX); Taber, J.J. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Sun Company is now completing its part in a contract with DOE to prepare samples of a range of hydrocarbon sulfonates that are of potential value for tertiary oil recovery. The New Mexico Petroleum Recovery Research Center and Sun will characterize these sulfonates by methods of current interest such as optimal salinity and salinity grids. At this time eight synthetic sulfonates have been prepared and are going through preliminary characterization. The schedule of preparation has been lengthened in order to observe maximum safety precautions in the use of sulfur trioxide. This group of sulfonates are based on hydrocarbons that are available in modern refining technology at low potential cost and in large amounts. All requests for samples and information should be sent to Dr. Taber. The Center, being an organization with no proprietary interest in this area, is to receive and distribute information. To realize the maximum benefit from this program it is hoped that the sharing of non-proprietary information as expeditiously as possible will facilitate further current research on enhanced oil recovery.

216 (CONF-780825—P1, pp A11.1-A11.20) **University of Florida research program on chemical oil recovery systems.** Shah, D.O.; Walker, R.D. Jr.; O'Connell, J.P. (Univ. of Florida, Gainesville). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The improved oil recovery research program at the University of Florida is a multidisciplinary research program designed to elucidate various interactions occurring between injection fluids, such as surfactant and polymer solutions and reservoir components, such as clays, minerals and oils. The following are the five major areas of research in this program: (1) interfacial phenomena, (2) bulk, surface and porous media rheology, (3) rock-fluid interactions, (4) polymer rheology and fluid mechanics, and (5) thermodynamic phenomena and phase equilibria. The research program is designed to establish a broad framework of knowledge about the microstructure of injection fluids and their behavior in porous media in relation to oil displacement efficiency. It is hoped that the development of the basic framework of knowledge and the quantitative relationships among various parameters of the process will assist industry in designing and optimizing chemical oil recovery systems for reservoirs under varying conditions. This paper reviews our accomplishments of the past one year in each of these areas.

217 (CONF-780825—P1, pp A12.1-A12.15) **Research supporting micellar floods: chemicals, tracers, and ion-exchange aspects.** Johnson, J.S. Jr. (Oak Ridge National Lab., TN). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Enhanced-oil-recovery work at ORNL is in three categories. The objective of "Chemicals for Enhanced Oil Recovery," the oldest, is to lower costs of chemicals used in micellar floods by finding cheaper sources of raw materials for them in waste streams or elsewhere or by finding lower cost processing methods. The second topic, an investigation of ion-exchange aspects of micellar floods, has dealt so far with two areas. One involves equilibrium distributions of alkali metal-alkaline earths between selected minerals and aqueous phases over a wide range of salinity. In the other area, the chemistry underlying micellar floods has been approached by miscibilities of aqueous-hydrocarbon systems modelling surfactant floods, with the exception that the surfactant surrogates have not had hydrocarbon chains long enough for formation of micelles. The third category involves search for new (inorganic) tracers to monitor underground fluid flow and the identification of salinities and of types of formations in which they might be useful.

218 (CONF-780825—P1, pp A13.1-A13.24) **Progress report for the El Dorado Micellar-Polymer Project, El Dorado, Kansas.** Miller, R.J. (Cities Service Co., Wichita, KS); Rosenwald, G.W. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The El Dorado Micellar-Polymer Project is a cooperative venture between Cities Service Company and the United States Department of Energy (DOE). The major field operations during the ten months ending in March, 1978 included completing injection of preflood in the north pattern, initiating injection of micellar solution in the north pattern, conducting a biocide testing program, and completing injection of micellar solution in the south pattern. The primary laboratory work during the ten-month period has included evaluating chemical slug compositions, monitoring injected fluid quality, examining produced fluids, analyzing observation well data, forecasting reservoir performance, and providing support for field related activities.

219 (CONF-780825—P1, pp A14.1-A14.16) **Technical Information Center support for the enhanced recovery program.** Grissom, M.C. (Technical Information Center, Oak Ridge, TN). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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220 (CONF-780825—P1, pp A15.1-A15.11) **Status report on DOE's micellar-polymer project in Nowata County, Oklahoma.** Burtch, F.W.; Thomas, R.D.; Walker, C.J. (Bartlesville Energy Research Center, OK). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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DOE's Bartlesville Energy Research Center is conducting a micellar-polymer flood in the Delaware-Childers field in NE Okla. The producing horizon is the oil-wet Bartlesville sandstone, at a depth of 620 to 700 ft, having a net thickness of 52 ft, an average permeability of 100 md, and an average porosity of 21%. Estimated oil saturation is 32 to 36% of 33° API gravity oil. Injection of the approximately 0.1 PV of micellar fluid was started April 28, 1976, following 5 months of brine preflush. Micellar injection was completed and polymer injection started October 5, 1976. Injection of the approximately 0.4 PV of polymer should be completed in August 1979. Total recovery from the 2 $^1/_2$ acre test site should be about 50% of the 70,000 bbl of oil in place. Pressure and flow for the injection wells are monitored instrumentally. Spot checks for the quality of injected and produced fluids are made by chemical analysis. Current injection and production history is discussed. Predictions of production curves and breakthrough times based on simple computer models using both laboratory and field data are discussed.

221 (CONF-780825—P1, pp B.1-B.25) **Development of laboratory screening tests to predict polymer performance in enhanced oil recovery. I. Shear degradation, viscosity, and electrolyte studies.** McCormick, C.L.; Hester, R.D.; Wildman, G.C.; Neidlinger, H.H. (Univ. of Southern Mississippi, Hattiesburg). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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An increasingly large number of water-soluble polymers are becoming available for utilization as displacement fluids in Enhanced Oil Recovery. Polymer-rock, polymer-polymer, polymer-surfactant, and polymer-solvent interactions must be understood to tackle the problems of shear degradation, shear thinning, adsorption, pore clogging, and mobility changes due to chromatographic, electrolyte, pH, and temperature effects. This paper deals with efforts to establish meaningful screening tests simulating expected field conditions. Initially, shear degradation, temperature, and monovalent electrolyte effects on viscosity are being studied. Laboratory polymers are being prepared under controlled synthetic conditions. Parameters including chemical structure, molecular weight, molecular weight distribution, ionic charge distribution, and branching are being determined for these laboratory models as well as for a series of representative commercial polymers. Methods of analysis include high pressure liquid chromatography, light scattering, carbon^{13} NMR, and classical viscosity methods. Shear degradation studies are being conducted in a modified Haake concentric cylinder viscometer and in packed columns of glass beads. Uniform simple shear rates up to 20,000 sec^{-1} are possible with this Haake viscometer and average porous media shear rates up to 100,000 sec^{-1} are measurable in the packed columns. Studies are being conducted to determine the degree of shear degradation as chemical structure and shear stresses are varied. A simple mathematical model based on perfect face-centered cubic packing of spheres has been developed to quantitatively predict shear rates through the packed columns.

222 (CONF-780825—P1, pp B2.1-B2.27) **Enhanced recovery with mobility and reactive tension agents.** Radke, C.J.; Somerton, W.H. (Univ. of California, Berkeley). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

To establish and improve recovery efficiencies of acidic crude oils with alkaline agents this project includes studies on displacement dynamics, interfacial tensions, emulsion flow and caustic loss. Displacement tests on restored Wilmington oil-field cores with caustic under anticipated field operating conditions show recoveries of about 30% of the oil remaining after water-flooding and caustic loss to the reservoir sand. Displacement results for synthetic systems show 50% tertiary recovery efficiencies under specific tailoring of pH and ionic strength. Concomitant experiments with interfacial tensions, contact angles, and emulsion type and stability demonstrate the importance of wettability alteration. Dynamic spinning-drop interfacial tensions of Wilmington crude oils show deep minima whose depth and attainment time are strong functions of pH and salt content. A mass transfer model, based on the concept of sorption barriers, correctly reflects these time-evolving tensions and permits extrapolation of the spinning-drop data to field conditions. An emulsion flow model based on filtration theory has been devised and numerically solved to predict correctly permeability behavior. Caustic adsorption loss on Ranger-zone Wilmington reservoir sand, determined by frontal-analysis chromatography, is critically dependent on pH.

223 (CONF-780825—P1, pp B3.1-B3.15) **Mechanism of oil bank formation, coalescence in porous media and emulsion stability.** Wasan, D.T.; Sampath, K.; McNamara, J.J. (Illinois Inst. of Tech., Chicago). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

A comprehensive study is underway to compare the role of coalescence-rupture processes in both surfactant and caustic flooding. This study includes microvisual observations of rupture-coalescence phenomena in oil bank formation and propagation, and emulsion stability problems in the low tension surfactant or micellar/polymer and alkaline systems. The recent research at IIT has developed a series of experiments which provide insight into the interrelationships between emulsion formation and coalescence in oil drop displacements, oil bank formation, interfacial fluid properties and oil recovery efficiency. High speed cinephotomicrographic examinations of spontaneous emulsification in the acidic California (Wilmington field) crude oil-alkaline solution as well as in the Illinois (Salem field) crude oil-petroleum sulfonate solution have revealed quite different mechanisms for alkaline agents as opposed to surfactant/polymer systems. The effects of interfacial viscosity, interfacial tension, interfacial charge and micellar aggregate distributions on coalescence, emulsion stability and oil recovery efficiency have been studied. Preliminary observations indicate that tertiary oil recovery is maximum for the system exhibiting the highest coalescence rates, i.e., for the least stable emulsions. It has been shown, moreover, that the rheological properties of surfactant films and the character of these thin films around emulsion droplets appear to be related and together determine the stability of oil in water emulsion.

224 (CONF-780825—P1, pp B4.1-B4.6) **Interfacial effects in the recovery of residual oil by displacement.** Slattery, J.C.; Kovitz, A.A. (Northwestern Univ., Evanston, IL). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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One analysis has been completed and another is advancing concerning the relative effects of the interfacial viscosities and interfacial tension during displacement. A new correlation has been developed for the dynamic contact angle as a function of capillary number. New techniques have been developed in interfacial viscometry. The meniscal breakoff interfacial tensiometer has evolved into a reliable instrument. The effects of adsorption upon the mea-

surement of interfacial tension in the meniscal breakoff, spinning drop, and sessile drop tensiometers is better understood.

225 (CONF-780825—P1, pp B5.1-B5.25) **Oil ganglia dynamics during immiscible displacement. Effects of interfacial properties.** Payatakes, A.C.; Flumerfelt, R.W.; Ng, K.M. (Univ. of Houston, TX). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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For given porous medium and immiscible flood conditions only a number fraction of the entrapped oil ganglia gets mobilized. Mobilized oil ganglia have a strong tendency to break into smaller ones. The ensuing smaller daughter ganglia become gradually stranded anew through random encounters with narrow throats. This tendency for deterioration by breakup and stranding can lead to very small microdisplacement efficiences; fortunately, it is counteracted by coalescence between "colliding" pairs of ganglia and remobilization. In order to study the transient behavior of oil ganglia populations during immiscible displacement, two coupled ganglia-number conservation equations are developed; one applies to moving ganglia and the other to stranded ones. Solution of these equations delineates the conditions under which oil bank formation succeeds or fails. The parameters entering this system are: average ganglion velocity, ganglion dispersion coefficients, ganglion stranding coefficient, probability of breakup, and probability of coalescence given a "collision." A systematic study is underway to determine these parameters as functions of the porous medium geometry, ganglion size, flood velocity, saturation and flood composition. Parts of this study require computer simulation based on a new porous media model consisting of a network of randomly sized unit cells of the constricted-tube type. In agreement with previous works, coalescence emerged as a critical process. The effects of interfacial properties on coalescence, in particular, and on the collective fate of the entire ganglia population in general, are currently being investigated.

226 (CONF-780825—P1, pp B6.1-B6.9) **Surfactant synthesis and micellar slug design at the Pennsylvania State University.** Klaus, E.E.; Stahl, C.D.; Danner, R.P.; Duda, J.L.; Farouq-Ali, S.M.; Jones, J.H. (Pennsylvania State Univ., University Park). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Sulfonates prepared by the sulfonation of vapor phase oxidation products of aliphatic mineral oil fractions have been evaluated as surfactants for enhanced oil recovery. Analysis of these surfactants indicates that they are primarily aliphatic sulfonates. These materials when mixed with brine solutions show low interfacial tensions with hydrocarbons. It appears that by an appropriate choice of equivalent weight of the aliphatic sulfonate, minimum interfacial tensions in the range of 10^{-3} dynes per cm can be obtained for hydrocarbons with equivalent carbon numbers ranging from C_6 to C_{16}. Data are presented to show that these surfactants show low interfacial tensions over a wide range of equivalent alkane carbon number. Low interfacial tensions are achieved with these surfactant solutions at surfactant concentrations of less than 0.5%. The addition of xanthan gum for viscosity control shows no significant change in interfacial tension over that of the surfactant solution above. Compatibility studies of brine-surfactant-polymer solutions show that those prepared with the aliphatic sulfonates show improved stability over those prepared with conventional aromatic sulfonates. Low concentration surfactant-polymer-brine solutions prepared with aliphatic sulfonates have been compared with similar solutions prepared with aromatic sulfonates and with more conventional high concentration slugs and polymer buffer solutions in long core tests. The low concentration surfactant-polymer-brine solutions prepared with aliphatic sulfonates show oil recovery values higher than those achieved with a comparable aromatic sulfonate. These high recovery values are comparable to those achieved with high concentration slugs and polymer buffer used in the current technology. In the case of the low concentration surfactant solutions, equivalent oil yields are obtained with much smaller total amounts of chemicals.

227 (CONF-780825—P1, pp B7.1-B7.18) **Improved oil recovery by alkaline flooding in the Huntington Beach Field.** Weinbrandt, R.M. (Aminoil USA, Inc., Huntington Beach, CA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1A.

Aminoil USA is conducting a pilot test of an alkaline flooding process in the Lower Main Zone of the Huntington Beach Field. The area where the alkaline flood is being pilot tested was originally drilled in 1940 and produced by primary means until 1969, at which time a pilot waterflood was initiated in Fault Block 22 using a single normal five-spot pattern. Approximately two pore volumes of water have been injected into the 17,000 ac. ft. project area and it is currently producing at a water-oil ratio of over 20. The same fault block and pattern where the waterflood was pilot tested is being used for the alkaline flood pilot program. This paper presents the results of the reservoir definition work which preceded this pilot test. The principal objectives of the reservoir definition work were to determine the amount and distribution of oil at a location in the pilot area that had been extensively waterflooded. The engineering techniques used to satisfy the project objectives were: analysis of conventional, plastic sleeve, and pressure cores; well logs; and analysis of past pilot area performance. Use of multiple evaluation methods has provided a check on the absolute accuracy of the parameter determination which would not be possible with a single method approach. The determination of oil in place after waterflood will be used to evaluate the recovery efficiency of the waterflood and as a base from which to evaluate the recovery efficiency of the alkaline flood pilot test.

228 (CONF-780825—P1, pp B8.1-B8.18) **Improved waterflooding with polymers: completion and evaluation of the North Stanley project.** Cunningham, J.W.; DuBois, M. (Kewanee Oil Co., Tulsa, OK). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The joint Kewanee-Energy Technology Branch of D.O.E. improved waterflooding demonstration project is nearing completion. After concluding polymer injection in June 1977, a four month fresh water buffer was injected. In October, 1977 injection was converted to produced water and will continue until conclusion of the project. Oil production has responded favorably and the current rate is 26% greater than the rate predicted without the polymer. Based on current production trends and the existing DOE/FERC pricing regulations, the project will make only a 10.9% pretax rate of return. This minimal rate of return includes a DOE/Energy Technology Branch contribution of $1,339,600 to help defray the investment cost. Projections have been made to determine the oil price necessary to realize a profit assuming today's prices and costs are held constant. A price of $8.00 per barrel is required simply to pay out the investment. A price of $13.30 per barrel is required to achieve a 15% rate of return which is considered the minimum acceptable with the level of risk involved.

229 (CONF-780825—P1, pp B9.1-B9.14) **Caustic waterflooding demonstration project, Ranger Zone, Long Beach Unit, Wilmington Field, Calif. (covering period June 1977—April 1978).** Carmichael, J.D. (Dept. of Oil Properties, Long Beach, CA); Mayer, E.H.; Alpay, O.A.; Boyle, P.R. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Laboratory core flood techniques were finalized. Evaluation of entrapment and entrainment flooding in Ranger Zone pilot area cores continued. The caustic-only (entrapment) core floods failed to demonstrate improved behavior. The caustic-salt (entrainment) core floods in contrast showed both substantial recovery and WOR improvement. Caustic water-oil dehydration testing and test softening of produced waters are in progress and nearing completion. The mini-injection test to evaluate the sustained effect of the injection of caustic fluids indicated no major drop in the ability to input caustic water with time. Simulator history matching of the area's waterflood behavior was begun. Ongoing analysis of the reservoir data obtained in special logging programs was continued. Additional repair/redrill/stimulation work was undertaken. Most major well work in the pilot area appears to have been completed. Installation of the pilot's additional injection facilities has started; the target for completion is the end of July, 1978, with the chemical injection preflush to begin immediately thereafter.

230 (CONF-780825—P1, pp B10.1-B10.24) **Coalinga Polymer Demonstration Project, Coalinga, California.** Peterson, J.E.; Tixier, C.E.; Killgore, T.L.; Swarbrick, J.C.; Bates, T.; Baxter, D.D.; Miron, R.L. (Shell Oil Co., Houston, TX). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Shell Oil Company, in conjuction with the Department of Engery, is conducting a field demonstration test of displacement mobility control through polymer flooding in Coalinga, California. The test is designed to determine the incremental oil recovery which can be obtained by polymer flooding over waterflooding. The project area consists of four inverted five-spot patterns in a multilayered reservoir. The waterflood phase of the project began in June, 1976. The polymer injection phase will follow, and is expected to start in May, 1978. Geological and petrophysical studies have defined the

reservoir continuity and rock and fluids parameters. The results from these studies have been incorporated into a three-dimensional, four-component numerical simulation model. The model will be used to analyze the primary, waterflood, and polymer flood performance and predict future performance. Four producing observation wells and one petrophysical logging observation well have been drilled in the pilot area. These wells have been designed to provide information regarding the vertical sweep efficiency, fluid saturation changes, and in-situ polymer quality in individual layers in the pilot area.

231 (CONF-780825—P1, pp B11.1-B11.9) **DOE in-house research on thermodynamics of oil-recovery micellar systems.** Noll, L.A.; Berg, R.L.; Good, W.D. (Bartlesville Energy Research Center, OK). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The interactions of micellar solutions with reservoir fluids and materials are being studied calorimetrically. This report describes the study of adsorption onto surfaces, part of the Bartlesville Energy Research Center study on the thermodynamics of enhanced oil recovery systems. The understanding of the strength and type of interactions between enhanced oil recovery fluids and reservoir surfaces will be an important contribution to the successful development of micellar-polymer flooding processes. Enthalpies of adsorption are being measured on well-characterized surfaces, both in a batch and in a flowing calorimetric mode. The flowing mode models surfactant flowing through a water-wet reservoir; the batch mode is closely related to classical heat-of-wetting experiments. A surfactant concentration detection method has been developed, and a calorimetric technique of determining surface area is being tested.

232 (CONF-780825—P1, pp B12.1-B12.8) **Enhanced oil recovery by improved waterflooding.** Edwards, J.N. (Energy Resources Co., Inc., Cambridge, MA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The objective of this project is to demonstrate a successful approach to controlled waterflooding using polymers, of the Storms Pool oil field in Illinois. This once highly productive field has yielded over 12,000,000 barrels of oil. It now contains a depleted gas cap, part of which is water-filled, as well as underlying ground water. The field has undergone extensive waterflooding for the past 20 years and is now in stripper production. Operated by a small, independent oil company, it is representative of a large number of old fields which are candidates for enhanced recovery, lying ouside the purview of the major oil companies. The use of polymers in the Storms Pool is to demonstrate the improvement of sweep efficiency, thereby showing that the technical, engineering, management, and financial resources necessary for tertiary oil recovery projects of this type can be applied to similar oil fields that might otherwise be abandoned due to lack of investment from major oil companies or other outside parties knowledgable in enhanced oil recovery technology.

233 (CONF-780825—P2) **Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Volume 1B. Oil.** Linville, B. (ed.). (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). 1978. 290p. Dep. NTIS, PC A13/MF A01.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

Contains papers of the following sessions: Session C. Carbon dioxide flooding; Session D. Thermal methods/heavy oil.

Papers on carbon dioxide injection and thermal methods for heavy crudes and bitumens are compiled in Volume 1B. Individual abstracts were prepared for inclusion in the EDB data base.

234 (CONF-780825—P2, pp C1.1-C1.28) **Study of CO_2 recovery and tertiary oil production enhancement in the Los Angeles Basin.** Shah, R.P.; Wittmeyer, E.E. (Lawrence-Allison and Associates, Santa Ana, CA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1B.

The objective of this study is to evaluate the technical feasibility of enhanced recovery of crude oil through the use of carbon dioxide flooding in the Los Angeles Basin. The study involves an evaluation of carbon dioxide sources, the requirements for upgrading and transmitting the gas, and necessary material specifications. Los Angeles Basin oil fields are being studied to determine qualitatively the applicability of carbon dioxide as a recovery agent and the anticipated recovery performance.

235 (CONF-780825—P2, pp C2.1-C2.15) **Granny's Creek CO_2 injection project, Clay County, West Virginia.** Conner, W.D. (Columbia Gas Transmission Corp., Charleston, WV). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Columbia Gas Transmission Corporation, in conjunction with the Department of Energy, is conducting a field demonstration of oil recovery by CO_2 injection in Clay County, West Virginia. The objective of this test is to evaluate and demonstrate the effectiveness of using CO_2 injection to recover high gravity crude oil from shallow watered-out reservoirs. The reservoir was repressured to approximately 1000 psi with water prior to CO_2 injection. The plant was completed and injection of CO_2 began on June 2, 1976. A total of 9800 tons of CO_2 was injected in several stages, alternating with water periodically for mobility control and better sweep efficiency. Injection of the CO_2 slug was completed on June 16, 1977. Water injection followed the CO_2 slug and continues to the present. Oil production from the central producer peaked shortly after the cessation of CO_2 injection and has continued until recently. Through April 1978, approximately 8500 barrels of additional have been recovered due to CO_2 injection.

236 (CONF-780825—P2, pp C3.1-C3.11) **Cost and availability of carbon dioxide for enhanced oil recovery.** Rump, W.M.; Shah, M.N.; Cover, A.E. (Pullman Kellogg, Houston, TX). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Pullman Kellogg, with assistance from Gulf Universities Research Consortium (GURC) and National Cryo-Chemics Incorporated (NCI), is preparing a comprehensive study of the carbon dioxide supply situation for the support of enhanced oil recovery projects using carbon dioxide for miscible flooding. The study deals with the economics of delivering carbon dioxide to the candidate oil fields/reservoirs, as well as with the location of all significant sources of carbon dioxide within regions of high potential for enhanced oil recovery by carbon dioxide miscible flooding. Multiple sources are considered including naturally occurring carbon dioxide, process vents and combustion flue gases. Detailed maps show locations and descriptions of the sources in terms of quantity, quality, and initial conditions. As far as possible, cost information developed will be presented graphically so that for a given source(s) all costs (production purification, and transportation) associated with delivery of carbon dioxide to a candidate field/reservoir can be determined.

237 (CONF-780825—P2, pp C4.1-C4.6) **West Virginia CO_2 oil recovery project interim report.** McRee, B. (Guyan Oil Co., Huntington, WV). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1B.

The Griffithsville Berea Sand CO_2 pilot test is operating under a DOE three year contract scheduled to expire August 28, 1978. The discovery of a salt water dump flood in the pilot area and extreme environmental problems and difficulties encountered in developing the project have resulted in lengthening the project timetable. Application has been made to DOE by the operator to extend their contract for a two year period. The extension in time is, in part, due to the need to (1) properly replug additional wells and obtain other observation wells and (2) increase the CO_2 requirements from 8000 to 30,000 tons. All fieldwork, reservoir analysis, well testing and repressuring to miscibility pressure have been completed within the 90 acre pilot area. All systems are ready for CO_2 injection.

238 (CONF-780825—P2, pp C6.1-C6.16) **Weeks Island "S" sand Reservoir B gravity stable miscible CO_2 displacement, Iberia Parish, Louisiana.** Perry, G.E. (Shell Oil Co., New Orleans); Guillory, A.J.; Baron, J.D.; Johnston, J.R.; Moranville, M.B. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Shell Oil Company in conjunction with the Department of Energy is conducting a gravity stable field test of the miscible CO_2 process. The test is being conducted in a 12,800-foot deep Gulf Coast reservoir. The future producing well was drilled in December of 1977. The residual hydrocarbon saturation has been investigated using logging devices and cores. Sheli has investigated the miscibility and phase behavior of the CO_2 and reservoir crude. Injection facilities have been constructed and CO_2 injection has been targeted for the Second Quarter of 1978.

239 (CONF-780825—P2, pp C7.1-C7.5) **Progress of the pilot carbon dioxide flood in the Rock Creek-Big Injun Field, Roane**

County, West Virginia. SanFilippo, G.P. (Pennzoil Co., Vienna, WV); Guckert, L.G. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Conventional extra recovery methods have not provided sufficient production responses in the Rock Creek Field. Total recovery to date has been approximately 20% of the original stock tank oil-in-place (OSTOIP). In this field, the remaining 80% of the OSTOIP is equivalent to approximately 150,000,000 barrels of oil. This large amount of oil remaining in the reservoir was one of the main reasons in designing and installing a pilot carbon dioxide project in the Rock Creek Field. The objectives of this pilot are to determine the oil recovery efficiency of a multiple contact carbon dioxide miscible flood and to define and evaluate operational problems associated with this particular recovery method. As of April 1, 1978, 1,131,638 barrels of water have been injected into the project. It is anticipated that carbon dioxide injection will be initiated during the second quarter of 1978.

240 (CONF-780825—P2, pp D1.1-D1.12) **Bodcau In Situ Combustion Project, Bellevue Oil Field, Bossier Parish, Louisiana.** Joseph, C. (Cities Service Co., Jackson, MS). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The objectives of the Bodcau In Situ Combustion Project are to demonstrate the efficiency and economics of a simultaneous air and water combustion process. Five elongated, inverted nine-spots were developed and ignited in 1976. The project is governed by DOE contract number EY-76-C-03-1189, and the contract period extends from June 1, 1976 through June 30, 1982. Virtually all the producing wells have been thermally stimulated by the combustion process and combustion front breakthroughs have occurred at twelve producers. The total producing cost is $9.47 per net barrel of oil produced.

241 (CONF-780825—P2, pp D2.1-D2.30) **Development and field testing of the vapor therm process in the Carlyle Pool-Allen County, Kansas.** Sperry, J.S.; Poston, R.S.; Young, F.S. Jr. (Carmel Energy, Inc., Houston, TX). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Carmel Energy, Inc. completed an 18-month cost sharing contract with the U.S. DOE in October, 1977 to demonstrate the commercial applicability of the Vapor Therm process on the Clinkenbeard lease in Allen County near the town of Iola, Kansas. A Vapor Therm generator capable of producing steam and inert gases was designed and constructed to ASME codes to deliver heated gases at 900 psi and 650°F. During thirteen months of cyclic stimulation-production, the wells produced at a sustained average rate of 7.82 BSTO/day and a water/oil ratio of 1.3. Total oil production during the four cycles was 9034 barrels of stock tank oil, indicating an enhanced recovery of 6.04% of original oil in place. The principal mechanisms responsible for the enhanced recovery include oil viscosity reduction due to heat and CO_2 solubility, oil expansion, gravity drainage, gas repressurization, and water encroachment. An analytical model of the process has been developed. The most significant problems encountered during these tests were sand production, water/oil emulsions, surface handling of produced fluids, injectivity of Vapor Therm gases, and gas leakage during production. Corrosion of steel tubulars and the presence of bottom water in the reservoir were not found to be detrimental to the application of the process in this reservoir. Economic analysis of the Vapor Therm process in the Carlyle pool indicates that a typical optimized development program would consist of 60 wells alternately stimulated by one Vapor Therm unit. Capital cost for such a program is $3,485,500 and annual operating expense is estimated to be $798,500/year.

242 (CONF-780825—P2, pp D3.1-D3.15) **Wet combustion pilot, Paris Valley Field, California.** Shipley, R.G. Jr. (Husky Oil Co., Santa Maria, CA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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Husky Oil Company with the support of the Department of Energy is operating a wet combustion and cyclic steam pilot in the Paris Valley Field, Monterey County, Californa. The objective of this project is to determine the economic viability of these thermal recovery techniques on high viscosity crude in which primary production averages less than 1 BOPD per well. As of April 1, 1978, 52 cyclic steam treatments were performed in 20 wells. Peak oil production of up to 200 BOPD has been observed in individual wells, but the rate drops sharply after two to four weeks. Improved oil recovery was obtained when air was simultaneously injected with the steam during stimulation. Operational problems with the air compressor had delayed continuous air injection until January 31, 1978. Air injection with good air injectivity is now being attained in four patterns. Gas analyses indicate excellent burning efficiency. Simultaneous air-water injection is expected to begin in May, 1978.

243 (CONF-780825—P2, pp D4.1-D4.12) **"200" sand steamflood demonstration project.** Alford, W.O. (Chanslor-Western Oil and Development Co., Santa Fe Springs, CA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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A test of steamflooding to improve recovery of 12° API, 6,500 CPS oil from the Spellacy Formation is being conducted in four 2.35 acre inverted seven-spot steam drive patterns in the Midway-Sunset Field, Kern County, California. This pool, designated the "200" Sand, contains approximately 50 million barrels of oil-in-place in an anticlinical structural feature between 400 and 700 feet in depth. The reservoir did not yield any primary production and responded unfavorably to cyclic steam stimulation, which is the principal recovery technique normally used to produce the tar-like crude in this area. Within the four patterns are two interior wells with two different methods of completion that will be key wells for determining production response for expanding the project. The project, which was commenced during the latter part of 1975, is now in the final work plan under Phase I. Continuing evaluation of the production response, economics, and reservoir data is being made to decide the merits of a continuation into Phase II of this project. Phase II will consist of expanding to the full-scale project of 14 inverted seven-spot patterns.

244 (CONF-780825—P2, pp D5.1-D5.28) **Heavy oil recovery research program at SUPRI.** Sanyal, S.K.; Brigham, W.E.; Ramey, H.J. Jr.; Marsden, S.S. Jr.; Kucuk, F. (Stanford Univ. Petroleum Research Inst., CA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The most effective means of recovery of heavy oils is the application of thermal recovery techniques. The studies at SUPRI have been applied research aimed at increasing the understanding of the thermal recovery techniques and improving their effectiveness. The studies made on flow properties, in-situ combustion, steam diverting agents, and analysis for solvents in heavy crude oil are summarized. (JSR)

245 (CONF-780825—P2, pp D7.1-D7.26) **Experimental investigation of the kinetics of underground combustion.** Thomas, G.W.; Buthod, A.P.; Allag, O. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1B.

This work is based on the supposition that the overall forward combustion process can be predominantly characterized by a simple two-step chain reaction, namely fuel laydown and fuel burnoff, which are essentially competitive, and both kinetically controlled. This represents an oversimplification of the actual phenomena involved and, indeed, ignores the role of diffusion controlled processes. However, it appears the chain reaction concept is compatible with earlier laboratory observations and recent mathematical studies which yield qualitative results similar to those seen in the laboratory. Nevertheless, one of the purposes of this work is to see if the essentials of the process can be characterized by the two-step hypothesis. Another goal is to develop a technique to determine the kinetic parameters governing fuel deposition and fuel burnoff from combustion tube data. A description of the experimental apparatus is briefly summarized. A moveable probe is described that permits fluid samples to be taken at different positions within the reactor. Experimental results from six combustion runs using a Prudhoe Bay crude and a procedure, currently under investigation, for arriving at the kinetic rate constants are reported. Computed results from a mathematical simulator are briefly discussed and compared with experimental data.

246 (CONF-780825—P2, pp D9.1-D9.14) **Use of chemical additives with steam injection to increase oil recovery.** Handy, L.L.; Ershaghi, I.; Amaefule, J.; Hsu, J. (Univ. of Southern California, Los Angeles). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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The use of surfactants as an additive for steamfloods is being evaluated to determine the effect on the residual oil saturation in the hot water swept portion of the reservoir and the effect on the overall oil-steam ratios. Methods have been developed for estimating the stability of sulfonate-type surfactants at elevated temperatures. The results show some dependence on surfactant type, but none of the surfactants tested appear to have adequate stability for reservoir use at temperatures in excess of 300°F. Extensive measurements have been made of the effect of temperature and brine salinity on the interfacial tension of certain sulfonate solutions against San Joaquin Valley crudes. Measurements made for the Witco TRS 10 to 80 sulfonate with a pendent drop apparatus have shown interfacial tensions less than 0.01 dynes/cm at 350°F and at 3.0% brine concentrations. Spinning drop equipment has been modified for use at elevated pressures and temperatures. Preliminary measurements with this apparatus indicate appreciably lower interfacial tensions than those obtained with the pendent drop. This is because the period of equilibration can be greatly extended. Equipment has been designed, constructed and is currently being tested for measuring surfactant adsorption on natural core materials as a function of temperature. Those results are not reported in this paper. An integral part of the program is to develop a mathematical model that will permit estimating the effects of the chemical additive on steamflood performance given the oil recovery and adsorption characteristics of the surfactant. The finite difference equations have been completed for the computer model and work is proceeding on the coding of the program.

247 (CONF-780825—P2, pp D12.1-D12.16) **Steamflood demonstration pilot, Williams Holding Lease, Cat Canyon Field, Santa Barbara County, California.** Hanzlik, E.J.; Schenck, H.; Birdwell, B.F. (Getty Oil Co., Ventura, CA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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A 20-acre steam displacement pilot is being conducted by Getty Oil Company in the Cat Canyon Field, Santa Barbara County, California. Continuous steam injection into the four inverted five-spot patterns was initiated in April, 1977. Preliminary well performance was adversely affected by significant thermal packer failures in the steam injectors. Eliminating the use of the packers in the injectors improved operations and pilot performance. Temperature response in the producing wells first occurred in November, 1977. Significant steam generaotr downtime due to replacing liners and gravel packs in the four injectors and in two producers is expected to delay steam breakthrough. Pilot performance and operating economics are discussed. Estimated ultimate recovery from the project is 850,000 barrels of oil.

248 (CONF-780825—P2, pp D13.1-D13.7) **Willow Draw Field, Attic Air Injection project, Park County, Wyoming.** Wilson, Q.T.; Oswald, D.D. Jr. (Oil Development Co. of Texas, Amarillo). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

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ODCOT, in conjunction with ERDA, is conducting a field trial of attic air injection in the Willow Draw Field, Park County, Wyoming. The subject reservoir is a small anticlinal trap of heavily fractured carbonate with low matrix permeability. The pool is filled with 13 to 16° API heavy crude, and is underlain by an active infinite aquifer. Primary recovery under these conditions was projected at 1% of OOIP. The subject test has dual objectives: (a) to increase oil production and reduce water production by offsetting oil production with injected air, and (b) to test feasibility of improving recovery of matrix oil in this type reservoir by a gravity powered gas/oil interchange along the face of gas filled fractures. Air injection started May, 1975, but continuous effective injection was not implemented until December, 1976. Results through December, 1977 were encouraging and in general conformance with theoretical predictions, but not conclusive. On January 19, 1978, air injection was ceased because a fire destroyed the injection plant. Injection will resume in June, 1978 after compressor replacement.

249 (FE—2605-06) **Large-scale samples of sulfonates for laboratory studies in tertiary oil recovery: preparation and related studies. Quarterly report, August—October 1977.** Malmberg, E.W. (Suntech, Inc., Richardson, TX (USA)). Jan 1978. Contract EF-77-C-01-2605. 28p. Dep. NTIS, PC A03/MF A01.

Activities are reported in a project which is to provide samples and information that will contribute to the resolution of current questions/problems in the nature and supply of oil recovery sulfonates. In exploring and evaluating feed stocks and reaction conditions, about 15 synthetic sulfonates have been prepared. The group is an expanded prototype of the sulfonates to be made as large-scale samples. These prototype samples have been used to evaluate methods of formulating and characterizing the sulfonates as oil recovery agents. A method of determining the equivalent weight of sulfonates has been developed with this group of prototype samples. A problem in interpreting and applying mass spectrometric analyses of alkylates has been resolved with this procedure. The feedstocks for the preparation of alkylate are on hand. The resolution of the equivalent weight question has confirmed the original estimates of distillation ranges, etc.

250 (GURC—159) **Chemicals for microemulsion flooding in E.O.R.** (Gulf Universities Research Consortium, Bellaire, TX (USA)). 15 Feb 1977. Contract EY-76-C-21-8025. 34p. Dep. NTIS, PC A03/MF A01.

A study was conducted to develop demand and supply information regarding those chemicals which are required in microemulsion flooding; to prepare forecasts of demand and determine the adequacy of supply; and, to interpret this information in a manner which will make it readily usable in policy formulation. It is concluded that the successful application of microemulsion flooding could make a significant contribution to the national production of petroleum. Microemulsion flooding is not a mature technology. It is not fully apparent that it will succeed in producing large volumes of oil within the next ten or fifteen years. The magnitude of the production targets and the rate of technology development are strongly influenced by externalities,—economic, social, and political factors. It must be understood by policymakers that abandonment of fields which, in a different economic climate, might produce from fifty to eighty percent as much oil as was produced in the primary phase very probably is permanent. As a result, deferment of successful enhanced oil recovery (E.O.R.) technology means a continuing loss of an important national resource. Accurate economic decisions regarding E.O.R. applications in general and microemulsion technology in particular are very sensitive to the price of oil. This is true both in relationship to the value of the oil produced and the cost of injected chemicals which are produced from petroleum feedstocks.

251 (METC/RI—78/9) **Applied simulation techniques for energy recovery.** Sawyer, W.K.; Mercer, J.C. (Department of Energy, Morgantown, WV (USA). Morgantown Energy Technology Center). Aug 1978. 124p. Dep. NTIS, PC A06/MF A01.

This report describes the development and application of a basic three-dimensional, three-phase (oil, water, gas) reservoir simulator for use in modeling secondary and tertiary oil recovery methods. Although fundamentally an immiscible simulator, ASTER provides an option whereby the gas phase may be treated as a solvent which is miscible with the oil phase. The Implicit Pressure-Explicit Saturation (IMPES) method is used which reduces the three-phase problem to that of solving a large system of linear equations each time-step. The solution of these equations is accomplished by one of three methods: PSOR, LSOR, or ADIP, all of which are well known.

252 (ORO—5301-28) **Oil recovery by carbon dioxide injection. Quarterly report, January—March 1978.** Sanfilippor, G.P. (Pennzoil Co., Vienna, WV (USA)). Apr 1978. Contract EF-76-C-05-5301. 26p. Dep. NTIS, PC A03/MF A01.

The progress of the Rock Creek carbon dioxide project in Roane County, West Virginia is reported. Designed, developed and operated by Pennzoil Company, this project is being conducted to demonstrate the feasibility of miscible carbon dioxide oil recovery in the Rock Creek Big Injun Field. During the first quarter of 1978, a sixty-three day labor strike by Pennzoil's field personnel occurred. This strike delayed the progress of the project by two months. The water supply and handling system performed trouble free throughout the quarter. The Henderson water source continued to provide an adequate water supply for the entire project. Water injection proceeded on schedule with the exception of one back-up injection well. A packer failure interrupted injection into this well prior to the start of the labor strike. The progress of the project and the corresponding cash outlay are depicted pictorially.

253 (ORO—5302-26) **Tertiary oil recovery by CO_2 injection. Quarterly report, January—March 1978.** Conner, W.D. (Columbia Gas Transmission Corp., Charleston, WV (USA)). Apr 1978. Contract EF-76-C-05-5302. 23p. Dep. NTIS, PC A02/MF A01.

A field test is in progress to evaluate and demonstrate the effectiveness of using CO_2 and water injection to recover high gravity crude oil from shallow watered-out reservoirs. The estimated recovery potential from the flood pattern of six (6) acres is approximately 50,000 barrels. Total water injection for the quarter was 14,663 barrels. Although this was approximately 1750 barrels less than previously, three of the four injection wells were acidized during the period and injection was much higher during March. To date no serious injection problems have occurred and the water supply remains adequate. Oil production for the period, while indicating a decline of 971 barrels for the quarter, showed a substantial increase during March. While 4254 (the center producer) continued at about the same rate, increases in both oil and water production

occurred in most of the outside producers, particularly well numbers 2046 and 4090. Total oil production that has been attributed to CO_2 injection is currently 8303 barrels.

254 Method of oil recovery by flooding employing betaine solutions. Koch, K.; Rutzen, H. (to Henkel Kommanditgesellschaft auf Aktien). US Patent 4,090,969. 23 May 1978. Priority date 10 Jan 1976, German, Federal Republic of (F.R. Germany). 8p.

A method of extracting mineral oil from subterranean formation by flooding is disclosed comprising the steps of forcing an aqueous liquid into a subterranean formation containing mineral oil and displacing the mineral oil through at least one bore hole in the subterranean formation, the aqueous liquid containing from 0.01% to 15% by weight of an amphoteric surface-active compound.

255 Successful injection pattern alteration, Pempina J. Lease, Alberta. McLeod, J.G.F. (Amoco Can Pet Co, Calgary, Alberta). *J. Can. Pet. Technol.;* **17**: No. 1, 51-55(Jan-Mar 1978).

In mid-1971, two years after conversion from gas to water injection, premature water breakthrough and a declining oil production rate indicated that Pembina J Lease ultimate recovery would be 18% of the original oil in place. A preliminary analysis indicated that re-aligning the injection wells to take advantage of an apparent directional permeability trend could significantly increase ultimate recovery. This paper presents a case history with particular emphasis on the preliminary analysis and the injection pattern re-orientation which accomplished the transformation of Pembina J Lease from a marginal producer to a highly profitable waterflood.

256 Effect of caustic concentration on interfacial charge, interfacial tension and droplet size: a simple test for optimum caustic concentration for crude oils. Bansal, V.K.; Chan, K.S.; McCallough, R.; Shah, D.O. (Univ of Fla, Gainesville). *J. Can. Pet. Technol.;* **17**: No. 1, 69-72(Jan-Mar 1978).

From electrophoretic mobility and interfacial tension measurements of crude oil/caustic systems, it was found that the minimum in the interfacial tension corresponds to the maximum electrophoretic mobility. A simple optical absorbance test was developed to determine the optimum caustic concentration necessary to produce the minimum interfacial tension and the maximum electrophoretic mobility. 18 refs.

257 Lower cretaceous geology and heavy-oil potential of the Lloydminster area. Orr, R.D.; Johnston, J.R.; Manko, E.M. (Husky Oil Ltd, Calgary, Alberta). *Bull. Can. Pet. Geol.;* **25**: No. 6, 1187-1221(Dec 1977).

Lloydminster comprises the most southerly deposit of the Alberta-Saskatchewan, Mannville heavy-oil sand belt. Hydrocarbon entrapment is controlled in part by updip sand pinchout, but is related primarily to regional anticlinal closure associated with salt solutions of the Middle Devonian Prairie Evaporite Formation. This area, with oil gravities ranging from 10 to 25 degrees API, differs from the rest of the "heavy-oil belt" in that it has demonstrated primary recovery. The Mannville sands of the Lloydminster area contain more than 16 billion barrels of oil in place. The reservoirs that have demonstrated primary production and were included in this estimate are the Colony, McLaren, Waseca, Sparky, GP, Lloydminster and Cummings sands. 10 refs.

258 Necessary tension in marine risers. Lubinski, A. (Smith Int, Inc, Irvine, Calif). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 6, 873-895(Nov-Dec 1977).

A simple, first approximation method for calculating the necessary tension in a marine riser for offshore drilling, is presented. The paper does not contain higher mathematics or computer programs. Only very simple equations are used, involving mathematical operations which are very easy to perform with any pocket electronic calculator. 16 refs.

259 Quantitative modelling of immiscible displacement in porous media: a network approach. Singhal, A.K.; Somerton, W.H. (Univ of Calif, Berkeley). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 6, 897-920(Nov-Dec 1977).

Adequate quantitative models for studying immiscible displacement in porous media are presently not available. As a consequence, the knowledge of multiphase flow in porous media has remained incomplete and mostly empirical. The study, a model of random, interconnected pore channels is constructed to represent a pore matrix, and four regimes of flow phenomena are included in simulation by incorporating concepts from both fluid mechanics and surface chemistry. By simulating displacement tests on the model under varying conditions, several insights about displacement mechanisms are deduced. The shortcomings of this model are pointed out and the next important steps towards a more realistic modelling are indicated. 44 refs.

PROCESSING

REFER ALSO TO CITATION(S) 19

260 Hydrocracking in the presence of water and a low hydrogen partial pressure. Egan, C.J. (to Chevron Research Co.). US Patent 4,097,364. 27 Jun 1978. Filed date 24 Mar 1976. 12p.

Disclosed is a process for hydrocracking high-boiling hydrocarbons to lower-boiling hydrocarbons under hydrocracking conditions including high concentrations of water and water precursors and a low partial pressure of hydrogen. Also disclosed is a combination process for the production of synthetic hydrocarbons from CO and H_2, wherein the CO and H_2 are contacted in a reaction zone containing both a Fischer-Tropsch hydrocarbon synthesis catalyst and a hydrocracking catalyst to produce a reaction product essentially free of oxygenated components. The synthetic hydrocarbons produced by the process of this invention are particularly useful as transportation fuels.

261 Separation of fluid mixtures. Giroux, V.A. (to Phillips Petroleum Co.). US Patent 4,097,371. 27 Jun 1978. Filed date 21 Sep 1976. 6p.

A fluid mixture, such as pyrolysis gasoline, is fractionated into at least two aromatic-rich streams. These streams are introduced into an extractive distillation column at different elevations, with the stream containing the highest boiling aromatic being introduced at the highest elevation.

262 Hydrotreating of pyrolysis gasoline. Minkkinen, A.A. (to Lummus Co.). US Patent 4,097,370. 27 Jun 1978. Filed date 14 Apr 1977. 6p.

In the hydrotreating of pyrolysis gasoline, recycle effluent is treated to separate the more volatile components therefrom, prior to recycle, to thereby increase the hydrogen partial pressure of the hydrotreating. In this manner, total pressures can be reduced to correspond to the pressure of the available hydrogen gas, while retaining the kinetic benefits of increased partial pressures.

263 Method of and device for distilling off secondary substances from oily liquids. Schumacher, H. US Patent 4,094,748. 13 Jun 1978. Priority date 16 Jun 1975, German, Federal Republic of (F.R. Germany). 6p.

Impurities or unwanted by-products are distilled off from an oily liquid by means of an ancillary stripping agent. The vaporization temperatures of the impurities and of the ancillary stripping agent lie below that of the oily liquid. Spontaneous distillation takes place in a decompressor to which the materials to be treated are supplied from a mixer or contactor. The decompressor comprises two nozzles arranged in series. In the decompressor the materials to be treated are subjected to a pressure considerably below the mixer pressure and somewhat below the separator pressure. Decomposition of the oil stream occurs in the decompressor into a non-volatile liquid phase and a vapor phase containing the ancillary stripping agent and the impurities originally in the oil feed. The mixed vapor/liquid stream enters the separator which is at a pressure which lies considerably below the pressure in the mixer.

264 Catalytic cracking process. Schwartz, A.B. (to Mobil Oil Corp.). US Patent 4,093,535. 6 Jun 1978. Filed date 15 Jun 1977. 32p.

A catalytic process for cracking of gas oil is disclosed, wherein trace amounts of metals of Periods 5 and 6 of Group VIII or rhenium is added to the total catalyst inventory so as to enhance significant conversion of the CO in the regenerator while maintaining the efficiency of the cracking reaction at high levels.

265 Catalytic cracking of residuals. Shioiri, T. (Nippon Oil Co, Ltd, Jpn). *Nenryo Kyokai-shi;* **57**: No. 2, 96-105(1978). (In Japanese).

Compared with a normal gas oil charge, atmospheric residues are unfavorable feeds for an FCC (fludized catalytic cracking) unit because of their higher contents of Ni and V compounds, coke precursors and sulfur. To overcome these problems, several methods are proposed, including the use of zeolite catalysts and riser cracking reactor system, the low conversion operating, the demetallization process and the combination of desulfurization and FCC. Some more recent techniques are also cited. 28 refs.

266 Heavy oil cracking process for production of olefins. Shohji, Y. (Chiyoda Chem Eng and Constr Co, Ltd, Jpn). *Nenryo Kyokai-shi;* **57**: No. 2, 87-95(1978). (In Japanese with English abstract).

Crude oil and residual oil cracking processes for the production of olefins are discussed and divided into four groups, according to the methods of preventing coking trouble in the reactor. These processes are: (I) The superheated steam cracking process which offers the advantage of cracking oils at high temperature and in short residence time, but which experiences difficulties in heat recovery.

(II) The cyclic cracking process which offers great flexibility in the choice of feed oils, but involves rather high construction costs. (III) The fluidized bed autothermic or partial oxidation process which minimizes coking problems, but has the disadvantage of production costs due to oxygen consumption. (VI) The circulating best carrier fluidized bed process which also offers the advantage of minimal coking trouble but requires no oxygen. One of the technically important points about this process is how to get high efficiency in the circulation system of the beat carrier. 19 refs.

267 Reduction of multiple oil supplies in linear refining programs. Bond, J.; Mayorga-Alba, E.; Offant, P. (Inst Fr du Pet). *Rev. Inst. Fr. Pet. Ann. Combust. Liquides;* **32**: No. 6, 959-971(Nov-Dec 1977). (In French).

A method is proposed for reducing the number of crude oils needed to make up the supply in linear programs of refining, in order to cut down on the size and calculation time of such models. The method uses techniques of multidimensional data analysis. An example is considered in order to illustrate the method. 3 refs.

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 1078, 1473

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 1575

268 Safety requirements for offshore engineering. Abrahamsen, E. *Mar. Sci. Commun.;* **4**: No. 2, 71-88(1978).

The problems of human and environmental safety for consideration by offshore engineers are discussed. Risk levels, quality assurance systems, and regulations are reviewed.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 211

WASTE MANAGEMENT

269 Microbial transformation of polycyclic aromatic hydrocarbons in pristine and petroleum-contaminated sediments. Herbes, S.E.; Schwall, L.R. (Oak Ridge National Lab., TN). *Appl. Environ. Microbiol.;* **35**: No. 2, 306-316(Feb 1978).

To determine rates of microbial transformation of polycyclic aromatic hydrocarbons (PAH) in freshwater sediments, ^{14}C-labeled PAH were incubated with samples from both pristine and petroleum-contaminated streams. Evolved $^{14}CO_2$ was trapped in KOH, unaltered PAH and polar metabolic intermediate fractions were quantitated after sediment extraction and column chromatography, and bound cellular ^{14}C was measured in sediment residues. Large fractions of ^{14}C were incorporated into microbial cellular material; therefore, measurement of rates of $^{14}CO_2$ evolution alone would seriously underestimate transformation rates of [^{14}C] naphthalene and [^{14}C]anthracene. PAH compound turnover times in petroleum-contaminated sediment increased from 7.1 h for naphthalene to 400 h for anthracene, 10,000 h for benz(a)anthracene, and more than 30,000 h for benz(a)pyrene. Turnover times in uncontaminated stream sediment were 10 to 400 times greater than in contaminated samples, while absolute rates of PAH transformation (micrograms of PAH per gram of sediment per hour) were 3,000 to 125,000 times greater in contaminated sediment. The data indicate that four- and five-ring PAH compounds, several of which are carcinogenic, may persist even in sediments that have received chronic PAH inputs and that support microbial populations capable of transforming two- and three-ring PAH compounds.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 268, 1403, 1413, 1414, 1476, 1529, 1531, 1542

270 (AED-Conf—77-193-001) **Energy demand and environmental pollution.** Bonus, H. (Dortmund Univ. (Germany, F.R.)). 25 May 1977. 9p. (In German). (CONF-770489—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting in connection with the Hannover fair target conflict-energy demand-environment; Hannover, F.R. Germany (20 Apr 1977).

Using the natural oil energy source as an example, the relation between the cost for the national economy, here called shortage cost, and the development of energy-saving and non-polluting technologies is outlined. Special emphasis is placed on the superiority of the market economy over dirigistic measures when it comes to solving the environmental problems.

271 (NP—23300) **Fishing and petroleum interactions on Georges Bank. Volume I. Areas of particular interest to the industries. Energy Program technical report 76-3.** Olsen, S.B.; Saila, S.B. (Rhode Island Univ., Narragansett (USA). Coastal Resources Center). Jan 1976. 37p. New England Regional Commission, Boston, MA.

A preliminary report has been prepared to summarize available geographic information on the distribution and relative intensity or abundance of various activities and environmental characteristics that will be of help in evaluating the potential interactions between fishing and petroleum industries. The report is designed to provide summary information with a minimum of technical detail to those responsible for managing and planning for the resources and industries in question. Information is included on potential for oil and gas, biological characteristics of Georges Bank marine life, fishing methods, and interrelationships among fishery resources, fishing, and petroleum development. (JRD)

272 (NP—23301/1) **Final environmental impact statement. Proposed 1978 Outer Continental Shelf oil and gas lease sale, South Atlantic: OCS sale No. 43.** (Bureau of Land Management, Washington, DC (USA)). 1978. 661p. Bureau of Land Management, Washington, DC.

An evaluation is presented of the environmental impacts associated with Federal leasing of 225 9-mile-square offshore tracts in the Southeast Georgia Embayment. A description of the proposal is given along with descriptions of the environment. Environmental impacts of the proposed action are examined along with mitigating measures included in the proposed action and alternatives of the proposed action. Actions to coordinate the proposal with others are outlined. (JRD)

273 (NP—23301/2) **Final environmental impact statement. Proposed 1978 Outer Continental Shelf oil and gas lease sale, South Atlantic: OCS sale No. 43. Appendices.** (Bureau of Land Management, Washington, DC (USA)). 1978. 265p. Bureau of Land Management, Washington, DC.

Fifteen appendixes are included on tract selection, resource recovery estimates, expected operations, pipeline control, DOI coordination activities, Coast Guard regulations, operational control, effects of petroleum on marine ecosystems, lease sale impacts, economic impacts, oil spill models, and DOI policies. (JRD)

274 (NP—23301/3) **Final environmental impact statement. Proposed 1978 Outer Continental Shelf oil and gas lease sale, South Atlantic: OCS sale No. 43. Visuals.** (Bureau of Land Management, Washington, DC (USA)). 1978. vp. Bureau of Land Management, Washington, DC.

Visuals are presented showing lease status, recreation, historic, and archaeological resources. Other visuals show geologic features, bottom sediments, undersea features, natural vegetation, wildlife species, offshore fisheries, oceanography, cyclone paths, and physiography. (JRD)

275 Computer evaluates cost of North Sea blowout oil spill. *Ocean Ind.;* **13**: No. 6, 96, 98, 101(Jun 1978).

The Sliktrack computer simulation estimates the cost of an average oil spill from a North Sea well blowout as 6 million dollars. Both primary and secondary cleanups were considered. If bridging occurred, total spill cost would probably not exceed 4 million dollars, but it would almost always be at least 0.5 million dollars. (DLC)

276 Positive-displacement pumps for emergency transfer of high-viscosity cargoes. Yates, J.B.; Hackman, D.J.; Tierney, J.M. (Battelle Columbus Lab, Ohio). *Pet. Eng.;* **50**: No. 5, 100, 103, 106, 110(May 1978).

This article deals with the use of lightweight, easily handled pumping systems based upon the positive-displacement pump that can provide the solution to salvage problems which crop up when tanker loaded with oil or liquid petrochemicals run aground or sink. The positive-displacement pump is more energy efficient at high viscosity. Used in conjunction with present emergency transfer systems that are effective with low-viscosity liquids, this type of pump can reduce the environmental and financial impacts of tanker casualties.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 1429

277 (EMD—78-48) **Lower Cook Inlet: another example of more data needed for appraising Outer Continental Shelf oil and gas resources.** (General Accounting Office, Washington, DC (USA)). 8 Jun 1978. 54p. U.S. General Accounting Office, Distribution Section, Box 1020, Washington, DC.

Report to the Congress by the Comptroller General of the United States.

The Lower Cook Inlet oil and gas lease sale held Oct. 27, 1977 was reviewed. It was found that the Department of the Interior selected and evaluated Outer Continental Shelf oil and gas tracts for leasing without obtaining enough information to determine their potential resources. It is recommended that Interior direct an exploration program which has a systematic plan for appraising Outer Continental Shelf oil and gas resources including selected stratigraphic test drilling.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 276

PROPERTIES

REFER ALSO TO CITATION(S) 212, 213, 214, 215, 216, 217, 221, 222, 224, 226, 231

278 (BETC/PPS—78/4) **Heating oils, 1978.** Shelton, E.M. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Aug 1978. 45p. Dep. NTIS, PC A03/MF A01.

Properties of 276 heating oils marketed in the United States were submitted for study and compilation under agreement between the Bartlesville Energy Technology Center (BETC) and the American Petroleum Institute (API). The fuels were manufactured by 27 petroleum refining companies in 96 domestic refineries. The data are tabulated according to six grades of fuel and subdivided into five geographic regions in wich the fuels are marketed. The six grades of fuels are defined by the American Society for Testing and Materials (ASTM) Specification D396. The five regions containing a total of 16 marketing districts are shown on a map in the report. Trend charts are included showing average properties of the six grades of fuel for the past several years. Summaries of the results of the tests by grade and by region for 1978 cmpared with data for 1977 are shown in tables. Analyses of Grades 1, 2, 4, 5 (light), and 6 foreign import oils are also tabulated.

279 (BETC/RI—78/13) **Low temperature total luminescence contour spectra of six topped crude oils and their vacuum distillate and residuum fractions.** Brownrigg, J.T.; Hornig, A.W. (Baird Atomic, Inc., Bedford, MA (USA)). Mar 1978. Contract EY-77-X-19-2570. 79p. Dep. NTIS, PC A05/MF A01.

Total luminescence spectra, in the form of intensity contours, have been developed for six topped crudes and their corresponding residues and vacuum fractions. All spectra were obtained at oil concentrations of approximately 10 ppM in methylcyclohexane at liquid nitrogen temperature, 77°K. The low temperature spectra provided additional information in terms of narrower spectral bandwidths and the additional appearance of phosphorescence. In particular, the variation of phosphorescence intensity among oils is substantial and would be useful for purposes of oil identification. As predicted from the effects of alkyl substitution on boiling point and spectral changes, the vacuum fractions show the greatest amount of sharp structure and the residues the least. An attempt has been made to identify principal emitting classes of compounds based upon published data and in-house work performed at Baird-Atomic. Because of the chemical complexity of the oils, these assignments must be regarded as tentative. The dominant fluorescence emission in all samples is probably due to derivatives of indole or carbazole. Weaker fluorescence emission is probably due to benzocarbazoles, fluorenes, naphthalenes, and anthracenes. The observed phosphorescence is believed to arise primarily from naphthalenes. Spectra of a greater number model compounds are needed in order to make more positive identifications. The value of low temperature spectroscopy as a means of obtaining greater luminescence information on oils is demonstrated. Chemical separation of the topped crude into two fractions is of value in predicting compound types present. Much useful work could be done, however, both with the existing data and in the realm of further experimental studies. This work should focus on mathematical methods of enhancing spectral differences, and on the identification of luminescing materials.

COMBUSTION

REFER ALSO TO CITATION(S) 165, 166, 167, 169, 545, 557, 563, 564, 565

NATURAL GAS

REFER ALSO TO CITATION(S) 858

RESERVES

280 (TID—28661) **Methane utilization from coalbeds for power generation. Quarterly technical progress report, April 1978—June 1978.** Sturgill, C.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). 1978. Contract EY-77-C-21-8098. 11p. Dep. NTIS, PC A02/MF A01.

Activities are reported in a program to demonstrate the economic utilization of mine gas (a diluted mixture of methane and air) as a fuel for gas turbine/electrical generator conversion of the mine gas to electrical energy. The work scope provides for the installation and operation of a system based on existing components usage. During the report period a gas turbine/generator was modified for use at the Ebensburg, PA site. Design drawings of the interface equipment were approved with comments in late May. Final drawing review was accomplished on June 21, 1978. Manufacturing release of the equipment was granted. Completion of the manufacturing effort is compatible with the need date at Ebensburg. Permission was obtained by Bethlehem from the land owner to utilize the new site for drilling a degasification well. A portion of the site was leveled, an access road put in and the location of the new well was spotted. Initiation of drilling has been delayed due to unforeseen difficulties in completing the necessary administrative preliminaries. Resolution is expected by July 17.

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 190, 191, 192, 193, 194, 195, 196, 197, 199, 201, 203

281 (CONF-780825—P3, pp E.1-Γ.18) **Log evaluation of compacted shaly sands of the Mesaverde Group, Uinta Basin, Utah.** Kukal, G.C. (CER Corp., Las Vegas, NV). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

The Gas Producing Enterprises/DOE MHF demonstrations in the Uinta Basin, Utah, constitute an important part of the FY 78 Western Gas Sands Project. Extensive coring and logging of CIGE 21-15-10-22, a Mesaverde test in the Bitter Creek Field, has provided a multitude of formation evaluation data. This paper analyzes log quality problems in the Mesaverde. Crossplot techniques are used to establish log validity, evaluate formation log parameters, and to provide methods for data normalization. Specific recommendations are made to improve the reliability of Mesaverde log evaluations.

282 (CONF-780825—P3, pp E3.1-E3.18) **Relation between facies and low-permeability (tight) reservoirs in the Northern Great Plains.** Rice, D.D.; Shurr, G.W. (Geological Survey, Denver). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Major natural gas resources are entrapped in low-permeability (tight) reservoirs at depths less than 4,000 ft in the Northern Great Plains. These shallow accumulations of gas are the product of the immature stage of hydrocarbon generation and are referred to as biogenic gas. Prospective reservoirs range in age from late Early Cretaceous to Late Cretaceous and include most of the section from the base of the Mowry Shale to the top of the Judith River Formation. To facilitate detailed examination, the potential reservoir section was divided into five intervals that consist of one or more formations and their correlatives. The intervals selected correspond to (1) Mowry Shale, (2) Belle Fourche Shale and Greenhorn Formation, (3) Carlile Shale, (4) Niobrara and Telegraph Creek Formations and Eagle Sandstone, and (5) Claggett Shale and Judith River Formation and their equivalents. Within any one interval, different facies occur. These facies were identified on electric logs and tied to nearby outcrops and cores. Each facies contains distinct reservoir types, some of which are tight. The following six facies were

identified and mapped for each interval: nonmarine rocks, coastal sandstones, shelf sandstones, siltstones, shales, and chalks. The siltstone and shale facies are grouped together at this time because conventional logs cannot distinguish between these two rock types, particularly when they are interbedded. For future evaluation of natural gas resources from low-permeability reservoirs, it will be necessary to separate these two facies. The most promising tight reservoirs are developed in the shelf sandstone, siltstone, and chalk facies. Reservoirs within these facies are particularly attractive because they are enveloped by thick sequences of shale which serve as both a seal and a source rock for the gas. Where naturally fractured, these shales may also be gas-bearing reservoirs.

283 (CONF-780825—P3, pp F2.1-F2.9) **Western gas sands coring program.** Newman, H.E. III (CER Corp., Las Vegas, NV); Mann, R.L.; Atkinson, C.H. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Cretaceous low permeability gas sands in the Rocky Mountain basins and adjoining regions represent significant amounts of potential natural gas resources. Coring select intervals of these sandstones, siltstones and shales is one of the primary steps in resource assessment and reservoir analysis. The Department of Energy will negotiate cooperative agreements or contracts with industry toward coring selected areas that have significant interest to the program. The coring program will include both field work and subsequent laboratory evaluations. The field operation will include recovering, describing, packaging and shipping of the cores to the proper laboratories. Routine core analysis will be done on most of the cores as well as special core analysis and tests on selected core samples. Normally the routine analysis will be performed by commercial laboratories and special core tests will be done by the government laboratories. The USGS will be responsible for archiving of all the core recovered in this program. A comprehensive suite of geophysical well logs will also be run in order to compare logs with core data. The objective is to develop accurate log interpretations that can be used for formation evaluation without the need for cores. Wells will also be production tested to supplement core and log information.

284 (CONF-780825—P3, pp G8.1-G8.14) **Concept of specific degasibility and its application to gas-bearing tight formations as represented by the Devonian shales of Appalachia.** Schettler, P.D. Jr. (Juniata Coll., Huntingdon, PA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Juniata College has been involved in the study of the kinetics of gas release from shale samples under closely-controlled laboratory conditions. This has led us to a parameter, closely related to the diffusion constant and permeability, which, however, directly expresses the rate of gas release as a function of rock type. This concept of specific degasibility is discussed in terms of our laboratory data and its possible applications.

285 (CONF-780825—P3, pp G9.1-G9.16) **Characterization and resource assessment of the Devonian shales in the Appalachian and Illinois Basins.** Zielinski, R.E.; Nance, S.W. (Mound Facility, Miamisburg, OH). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Upper Devonian shales from the Appalachian and Illinois Basins were evaluated to establish the depositional environment, organic source, thermal maturation, and hydrocarbon yields. Cored shale samples from six Appalachian Basin wells and five Illinois Basin wells provided data for biostratigraphic studies and geochemical analysis of the kerogen. Fuel yields were determined using organic carbon content, material balance assays, and core gas analysis. Woody and coaly material of a non-marine origin dominated the southern Appalachian Basin. Northern Appalachian Basin and Illinois Basin samples have a predominance of amorphous and herbaceous material indicative of a marine depositional environment. Appalachian Basin shales have experienced a sufficient degree of thermal maturation to yield hydrocarbons. Results from Illinois Basin samples are less definite. Hydrocarbon yields from the Appalachian shales were low and tended from oil and gas to gas-prone in a southeasterly direction. Illinois shales were oil- and gas-prone with comparatively higher yields.

286 (CONF-780825—P3, pp G10.1-G10.8) **Integrated study of the Devonian-age black shales of eastern Ohio.** Struble, R.A. (Ohio Dept. of Natural Resources, Columbus). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

As part of the effort of the U.S. Department of Energy's Eastern Gas Shales Project to evaluate the potential natural gas reserve of the Devonian shales in the Appalachian basin, the Division of Geological Survey, Ohio Department of Natural Resources, has undertaken an integrated study of these shales in Ohio. The study includes (1) subsurface stratigraphic analysis using borehole geophysical logs, core, and drill cuttings from selected wells penetrating the shale section, (2) clay mineralogy and petrographic analysis of samples from core available from the project and other core on file at the Geological Survey, (3) geochemical analysis of sample splits from core at the same intervals used in the mineralogic and petrographic investigations, (4) fracture analysis of eastern Ohio using satellite and low-altitude remote-sensing imagery, and (5) gas-show monitoring in selected currently drilling oil and gas wells in Ohio. All elements of the integrated study are underway but most are in preliminary stages. Upon completion of the study the combined data from the above investigations will provide a basis for assessing the most promising stratigraphic horizons within the shales for occurrences of natural gas and favorable areas of the state for exploration for natural gas from the Devonian shales. The integrated study also will provide data useful in the planning and design of production-stimulation techniques.

287 (ORO—5204-27) **Carbonaceous shales of Indiana as sources of energy, petrochemicals, and ceramic materials. Quarterly technical progress report, April, May, June, 1978.** (Indiana Geological Survey, Bloomington (USA)). 1978. Contract EY-76-C-05-5204. 14p. Dep. NTIS, PC A02/MF A01.

Activities in survey programs are reported. A site for taking a core of New Albany Shale has been selected in Clark County. Work continued on drafting final copies of the interlocking stratigraphic cross sections in the Illinois and Michigan Basins. Minor corrections and additions are being made as drafting continues. Illinois Basin: Work continues on preparation of the preliminary isopach map of the Sweetland Creek Member in the Illinois Basin. Samples from key wells were examined to establish the relationship of the Sweetland Creek Member with the overlying Grassy Creek Member and underlying Blocher Member as accurately as possible. Preparation of an isopach map of the Blocher also continued during the quarter. Correlations have been established for the unit from its type section in Scott County to sections in the Illinois Basin and along the outcrop. Sample studies are being made at intervals along each of the stratigraphic cross section lines. Maps showing structure and gas wells are being compared with other maps of the region on which lineaments are plotted. A summary of the study of these relationships will be included in the preprints of the Second Eastern Gas Shales symposium.Preliminary results of x-ray and petrographic studies of New Albany Shale from the Phegley well, from Survey Drill Hole No. 275, and from core C-2, which was drilled near Indianapolis by the American Aggregates Company are shown in the tables which accompany this report. These tables indicate a preliminary but rather complete, summary of the minerals comprising the New Albany Shale. A summary of efforts devoted to chemical analysis of drill cores is also included. (JRD)

288 (ORO—5207-1) **Physical and chemical characterization of Devonian gas shales. Eastern Gas Shale Project report No. 18. Final annual report.** Brownell, W.E. (New York State Coll. of Ceramics, Alfred (USA)). Jan 1978. Contract EY-76-C-05-5207. 166p. Dep. NTIS, PC A08/MF A01.

Quantitative mineralogical analyses for major minerals and qualitative analyses for trace minerals were made on 28 samples, all of which were analyzed chemically. Quartz grain-size distributions were measured on 28 samples. Physical tests made on several samples were hardness, density, point-load strength, directional-tensile strength, air permeability, directional-sonic velocity, and pore-size distribution. It was found that the clay mineral, kaolinite, was a major mineral in Well Core No. 20336, but no traces of kaolinite were formed in the Devonian shales of New York State. Both the point-load and directional-tensile strengths showed that the Devonian shales, in general, were stronger in the NW-SE direction than in the NE-SW direction. It was also observed that the shales were stronger with increasing quartz or silicon contents and weaker with increasing amounts of micaceous, disilicate minerals. As expected from previous work, the quartz grain-size distributions were skewed toward the larger sizes when the frequency curves were plotted linearly. An exhaustive analysis of all the data obtained was not attempted, since it was not a part of the contract.

289 **Automated analysis and pre-planned forecasting of factors for the preparation of natural gas resources.** Istomin, A.N. *Geol. Nefti Gaza;* No. 7, 50-54(Jul 1977). (In Russian).

The preparation of gas resources as a system was shown to comprise two parts--the synthetic (geological survey process) and

the natural (geological conditions for the location of gas accumulations). The process of gas resource preparation is described by a system of regression equations and time series equations. Numerical computations performed on a computer, including computations for prospective resources, with respect to the Dneprovsko-Donetsk depression and the Pre-Carpathian deflection correlated well with actual data and with computations made by the traditional geological methods. This direction in the geology of natural gas has been defined as resourcesology. 3 illustrations, 6 references.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 204, 859, 1243

290 (CONF-780825—P3, pp E2.1-E2.24) **Continuity and permeability development in the tight gas sands of the Eastern Uinta Basin, Utah.** Knutson, C.F.; Boardman, C.R. (C. K. GeoEnergy Corp., Las Vegas, NV). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Outcrop and subsurface studies of the tight gas sands of the Eastern Uinta Basin, Utah indicate that the gas bearing elements are generally lenticular. Outcrop studies have provided some insight into probable geometric ratios—the height:width:length average about 1:22:250. Production curves for about 20 Eastern Uinta Basin wells were analyzed for radial or linear (lenticular) performance. About 75% of the wells appeared to produce from linear reservoirs, about 5% from radial reservoirs, and the remaining were indeterminate. The calculated median permeability from the linear wells was 150 μd, while the calculated radial permeability was 12 μmd. The small number of wells analyzed makes any broad generalization from these analyses inappropriate; however, there is an indication that perhaps some of the enigma of western "tight" gas production is a result of the discontinuous geometry instead of characteristic permeabilities in the few microdarcy range.

291 (CONF-780825—P3, pp G4.1-G4.14) **Results of a pilot study of Cottageville Field, Jackson and Mason Counties, West Virginia.** Negus de Wys, J.; Shumaker, R.C. (West Virginia Univ., Morgantown). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Gas production data from 63 wells in the Cottageville Gas Field, producing from Devonian shales, are studied in relationship to structure above and below the producing horizons, isopach data and dip aspects including highest annual production, first five years accumulated production, total accumulated production, mean annual production, initial well pressure, and calculated loss ratio values for four (4) different time periods. A trend correlation of these parameters is presented. It is concluded that this approach could be useful in gas exploration and development evaluation of Appalachian Devonian shale gas fields.

292 (CONF-780825—P3, pp G7.1-G7.9) **Structural parameters that influence Devonian shale gas production in West Virginia and eastern Kentucky: a summary of progress for 1977—1978.** Shumaker, R.C.; Negus de Wys, J.; Dixon, J.M.; Kirk, K.G.; Long, B.R.; Nuckols III, E.B.; Rauch, H.W.; Wheeler, R.L.; Wilson, T.H. (West Virginia Univ., Morgantown). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Steady progress was made toward obtaining our objective of defining the structural parameters that influence shale gas production. Significant results based on fracture analyses of oriented shale cores show several types of fractures (porous fracture facies) developed in productive zones. Inclined slickensided fractures are different from the fractures we mapped in overlying surface sediments. The porous fracture facies may have formed by differential tectonic shortening across the shale. Results of a pilot study documenting production characteristics of the Cottageville Field, Jackson County, West Virginia, were reported. Some thirty-five preliminary regional structure maps at 1:250,000 scale, are now complete for the contract area. Field work investigating fractures is underway to define: (1) the vertical and lateral extent of the fracture facies, (2) the nature, orientation, and intensity of fractures within surface lineament zones, and (3) the extent of late stage open-fractures in Appalachian folds. A comprehensive study of the Eastern Kentucky Gas Field was initiated. Initial field testing of a shallow high-frequency seismic system and a metamorphic area to define fracture zones was inconclusive. Further study in sedimentary terrains utilizing a newly designed energy source should provide more definitive testing of the system's capabilities.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 1575

MARKETING AND ECONOMICS

293 (DOE/FERC—0005) **1978 National Gas Survey: report to the Federal Energy Regulatory Commission by the Technical Advisory Committee on Finance.** (National Gas Survey (USA). Technical Advisory Committee on Finance). Jun 1978. 156p. Dep. NTIS, PC A08/MF A01.

An overview is given of the gas industry and its financial problems, which have continued to worsen over the past several years. Actions needed to attract capital and regulatory reforms which are needed are discussed. Causes of inflation are examined. Information on projected capital expenditures of the gas industry are surveyed and evaluated. The gas production, transmission, and distribution sectors are considered separately. (DLC)

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 271, 272, 273, 274, 1326

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 1299

294 (CONF-780825—P3) **Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Volume 2. Gas and drilling.** Linville, B. (ed.). (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). 1978. 424p. Dep. NTIS, PC A18/MF A01.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

Contains papers of the following sessions: Session E. Supporting research for enhanced gas recovery; Session F. Enhanced gas recovery (western); Session G. Eastern gas shales; Session H. Drilling and rock mechanics.

Papers on supporting research for enhanced gas recovery, enhanced gas recovery in the Western states, eastern gas shales, and drilling and rock mechanics were compiled in Volume 2. Individual abstracts were prepared for inclusion in the EDB data base.

295 (CONF-780825—P3, pp E6.1-E6.27) **Theoretical and experimental research on hydraulic fracturing.** Hanson, M.E.; Anderson, G.D.; Shaffer, R.J.; Emerson, D.O.; Heard, H.C.; Haimson, B.C. (Univ. of California, Livermore). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

We are conducting a joint theoretical/experimental research program on hydraulic fracturing. Newly developed two-dimensional numerical models (which include complete descriptions of the elastic continuum and porous flow fields) have been applied to analyze the effects of pore pressure on the Mode I stress intensification factor. We have made predictions of surface tilt above a vertical hydrofracture and a horizontal layer, assuming various elastic parameters in the layer and the surrounding medium and different layer widths and positions relative to the hydrofracture. Experimentally, we have been studying the growth of cracks near an interface in several materials, including polymethylmethacrylate (PMMA), Nugget sandstone, and Indiana limestone. Results have shown that the mechanical properties of the interface relative to the properties of the materials on either side are important. Other experiments with triaxial loading cells have indicated that when vertical stresses are greater than horizontal stresses, a horizontal stress difference of greater than 75 psi controls the orientation of the fracture. We have completed a review of information generally available about the structure, stratigraphy, geometry, and properties of the Cretaceous and Tertiary media that make up the tight, western gas sands.

296 (CONF-780825—P3, pp F1.1-F1.11) **Western Gas Sands Project.** Appledorn, C.R. (CER Corp., Las Vegas, NV); Luetkehans, G.R.; Atkinson, C.H. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

The Department of Energy (DOE) initiated the Western Gas Sands Project to develop resource information and pursue technological improvements in characterizing and stimulating the low permeability reservoirs of the western United States. Previous studies have estimated natural gas resources of as much as 730 TCF in the largest four of twenty basins. Most of this potential source, however, is found in low permeability or "tight" sand-shale sequences that cannot be exploited economically with current technology. The principle activities of the project are: resource assessment, laboratory research and development, and field research, development and demonstration. Resource assessment will include geological and geophysical studies to define the physical aspects of gas generation and entrapment and to delineate the characteristics of the reservoir and source rocks. Laboratory research and development will concentrate on developing equipment and techniques to more accurately evaluate the resource. Rock and stimulation mechanics, fracture geometry, and simulated in situ measurements of reservoir characteristics will be emphasized. Simulation and modeling studies will provide new bases for analyses of production behavior and stimulation effectiveness. Field tests will aid in the development of techniques for formation evaluation, logging instrumentation and interpretation, production testing, and stimulation. Joint experiments between DOE and industry will be utilized, ranging from limited, single-purpose "add-on" experiments in single wells to multiple-company "task force" participation in multi-well programs. The experiments will aid in tool and technique development and will involve coring and logging in selected intervals, stimulation research, production testing and economic analysis.

297 (CONF-780825—P3, pp F3.1-F3.14) **Progress report and review of Natural Buttes Unit Massive Hydraulic Fracturing project.** Merrill, R.G. (Gas Producing Enterprises, Inc., Denver). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

A Massive Hydraulic Fracturing program was initiated in the Natural Buttes Unit, a marginal gas field located in the Bitter Creek Field in the Uinta Basin of northeastern Utah. The program includes fracturing nine wells (new and old) with different combinations of types and volumes of fluid, size and amount of sand and methods of placement to find the completion procedure which is the most effective in recovering gas from these low permeability sands. The program also includes fracture orientation tests on various wells and coring, extensive electric logging, pre-fracture testing, etc., on one well. To date, one well has been cored with over 500 feet of recovery and six wells have been fractured under the program.

298 (CONF-780825—P3, pp F4.1-F4.6) **Cyclic dry gas injection project, Dakota J Sand, Wattenberg Field, Colorado.** Fredrickson, H.R. (Colorado Interstate Gas Co., Colorado Springs). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Colorado Interstate Gas Company (CIG), in cooperation with the Department of Energy, is conducting a field test to determine if the productivity of wells completed in natural gas reservoirs of low permeability can be improved by reducing the interstitial water saturation in the reservoir. Cyclic injection of dry natural gas is the method to be tried to accomplish the reduction of the water saturation. In addition to reducing the water saturation, cyclic injection of dry natural gas may improve the productivity through effects such as the dehydration of matrix clays and amelioration of surficial damage adjacent to the induced fractures. The primary basis for undertaking this field test is empirical. CIG has observed substantial increases in the deliverability of storage field wells with cycles of injection and withdrawal. In one field the original open-flow potentials averaged about 1 MMcf per day but, subsequent to many cycles of injection and withdrawal, the wells' open-flow potentials reached 100 MMcf per day. These observed productivity improvements are greater than expected from core-derived relative permeability relationships. Two existing Dakota J Sand wells in the Wattenberg Field, Weld County, Colorado, will be used in this field test.

299 (CONF-780825—P3, pp F5.1-F5.13) **Fourth frac treatment, Well Federal 498-4-1, Rio Blanco County, Colorado. A progress report.** Ishteiwy, A.A. (H. K. van Poollen and Associates, Inc., Littleton, CO). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

A moderate volume fracturing treatment was performed on a 600-gross-foot section of the Mesaverde/Fort Union in Rio Blanco Natural Gas Company Well Federal No. 498-4-1. The treatment was designed to stimulate a multiple sand sequence at a minimum cost. The gross interval contains four separate sands with log-calculated net thickness, porosities, and water saturations of 30 to 60 feet, 8.5% to 11.5% and 48% to 55%, respectively. After performing extensive remedial cementing and perforating, each individual zone was isolated and selectively broken down with acid, nitrogen and ball sealers. Commingled post-breakdown gas flow tested 100 to 130 MSCF/D. The frac treatment consisted of 143,000 gallons of gelled 2% KCl water, 44,000 pounds of 100-mesh sand, 214,500 pounds of 20/40-mesh sand and 22,500 pounds of 12/20-mesh glass beads mixed with the sand as tail-in proppant. The well was fracted down tubing at 40 BPM and 2,300 to 3,900 psig. The post-frac tests indicate a rate of 350 SCF/D and approximately 1 BPH of water, which is attributed to the middle two intervals. Water production from all zones commingled was relatively high; in excess of 10 BPH. Water entry is believed to be through the perfs in the uppermost sand and the water source is possibly from some water-bearing sands up the hole. Additional field work is required to determine water source and fully evaluate the results of this treatment.

300 (CONF-780825—P3, pp F7.1-F7.12) **Demonstration of massive hydraulic fracturing, Piceance Basin, Rio Blanco County, Colorado.** Fitch, J.L.; Medlin, W.L. (Mobil Research and Development Corp., Dallas). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

A thick sequence of gas bearing sands and shales underlies the productive Wasatch Formation in Mobil's Piceance Creek Field. Demonstration that massive hydraulic fracturing will provide commercially attractive gas production rates from these sands is being attempted by Mobil with financial assistance from DOE. During 1977 a well was drilled, logged, and cased to 10,800 ft. Five promising intervals between 9,086 ft. and 10,680 ft. have been perforated and tested. Of these, two intervals were judged to have permeability-thickness great enough to justify massive fracturing. About 600,000 pounds of sand were placed in each of these intervals. After the testing and fracturing work was completed, the well was cleaned out to total cased depth and all open zones were put on production on January 18, 1978. The initial flow rate was 3.0 million cubic feet per day. By February 16 the flow rate had declined to 1.5 million cubic feet per day. Details of the testing and fracturing are given in the text. Additional potentially productive zones in the interval 7300 ft. to 9086 ft. will be tested in 1978. Up to four additional massive fracturing treatments will be performed in 1978 if the test results show that these zones possess sufficient permeability-thickness.

301 (CONF-780825—P3, pp G1.1-G1.15) **Strategy for stimulation technology in the Devonian shale.** Komar, C.A. (Morgantown Energy Technology Center, WV). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

The gas productivity of shale wells depends on the density and extent of natural fractures with the shale, the matrix organic carbon content source, and the effective communication of the wellbore with the fracture system. Stimulation techniques are usually required to achieve adequate communication. A strategy for stimulation technology is currently being developed for subsequent testing in various regions in the Basin. The strategy involves the selection of explosive technology and/or advanced hydraulic fracturing technology as an effective approach for increasing productivity. The selection of a particular stimulation design could be based on the thickness of the potential productive units and the degree of fracture density (the magnitude of tectonic stresses) found in the various regions of the Basin. Limited production history exists in the shale for the comparison of explosive fracturing and hydraulic fracturing stimulation techniques. Development of a rationale for stimulation design indicates different techniques may be determined to be more effective for site specific geologic conditions. Execution of the stimulation strategy to select techniques for definable geological conditions can permit a statistical evaluation of factor interaction effects which can lead to the selection of an effective treatment for various geographic regions in the Basin. Evaluation of production and pressure history prior to and after stimulation of new wells in the program is planned. The effects of non-controllable factors (such as formation richness and fracture density) and controllable parameters (such as volume, injection rate, proppant displaced and efficiency of hydraulic or explosive energy transmission into the formation) optimum productivity from a shale well can be planned.

302 (CONF-780825—P3, pp G2.1-G2.14) **Investigation of hydraulic fracturing technology in tight gas reservoirs.** Forrest, R.M.; McKetta, S.F. (Columbia Gas System Service Corp., Columbus, OH). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

In two jointly sponsored DOE programs, Columbia has been investigating hydraulic fracturing techniques to enhance gas recovery from impermeable, low pressure reservoirs in the eastern United States. The scope of investigation encompasses varying the size of hydraulic fracturing treatments from conventional to MHF-type treatments in several sandstone reservoirs and the Devonian Shale. The major purpose of this research effort is to delineate which treatment type will most effectively and efficiently promote gas production from the reservoirs under investigation. The type of hydraulic fracturing processes investigated include the use of foam, cryogens, and gelled water. To date, twelve MHF treatments, eight cryogenic-type treatments and one dendritic Kiel frac have been conducted in the Berea sandstone, the Clinton sandstone and the Devonian shale. This paper discusses some aspects in designing these treatments and the results obtained from this research endeavor.

303 (CONF-780825—P3, pp G3.1-G3.11) **Chemical explosive fracturing of Devonian shale gas wells.** LaRocca, S.J.; Spencer, A.M. (Petroleum Technology Corp., Redmond, WA). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

The use of a chemical explosive to enhance gas recovery from low pressure, tight, gas bearing formations has been investigated in a joint DOE and industry test program. The test program entailed remote placement and detonation of approximately 30,000 pounds of Petroleum Technology Corporation's (PTC) proprietary liquid explosive in three Devonian Shale wells in Lincoln County, West Virginia. The primary purpose of the investigation is the generation of basic data pertinent to the technical and economic evaluations of chemical explosive fracturing, as applied to the Devonian Shale. A secondary purpose of the investigation involved the use of imagery analyses to locate the well drill sites. This paper presents the results achieved from this research field test program.

304 (CONF-780825—P3, pp G5.1-G5.16) **Evaluation of stimulation technologies in the Eastern Gas Shales Project.** Young, C. (Science Applications, Inc., Fort Collins, CO). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

A technical review has resulted in the clarification, modification, and/or reaffirmation of the intermediate term research objectives for the Eastern Gas Shales Project (EGSP). This review has defined the key problem areas remaining to be addressed in the EGSP and has identified two key areas for increased consideration in the immediate future. The first area concerns resource characteristics related to production and stimulation and potential. The second area concerns the critical analysis and field demonstration of stimulation methods potentially capable of increasing Eastern Gas shales reserves. Both the quantitative definition of the total resource and the potential reserves, and the design, application and evaluation of stimulation methods require that the production characteristics of the shale be quantitatively described. The resource characterization efforts which have been conducted on the Devonian shales to date should be augmented and extended so that reservoir characteristics related to production behavior are adequately defined in terms of regional, stratigraphic, geologic and tectonic variations. Field demonstration projects must be carried out to verify the results of the modeling efforts and the field applicability of the more promising stimulation methods. The results of the evaluation, development and demonstration efforts on stimulation methods can be coupled with the reservoir production characteristics so as to provide an acceptably reliable description of the Devonian shale resources and potential reserves.

305 (LA-UR—78-1285) **Progress in explosive rock penetration.** Schott, G.L.; Marsh, S.P.; Mautz, C.W.; Burback, R.L.; Carter, W.J. (Los Alamos Scientific Lab., NM (USA)). [nd]. Contract W-7405-ENG-36. 16p. (CONF-780825—7). NTIS, MF A01.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

Portions of document are illegible.

As part of the Eastern Gas Shales Project, the Los Alamos Scientific Laboratory is investigating the application of improved shaped charges lined with uranium metal to the open hole explosive stimulation of gas in tight, carbonaceous shales. Above ground testing methods for charges having several pounds of explosive were developed and used to determine optimum thickness of uranium liner in hemispherical charges as a reference design. Tests with encased core specimens were made with commercial perforator charges lined with copper cones to intercompare the penetrabilities of synthetic grouts with shales and reference rock types. Advanced charge design using tapered thickness of the smoothly concave liner to achieve controlled, on-axis collapse and high-performance jets are analyzed by hydrodynamic computer methods prior to selection for fabrication and experimental firing. Remaining problems include determination of threshold velocity for penetration of rock, sensitivity of rock penetration to charge standoff, and the coupling of explosive rock penetration to the stimulation characteristics of shale formations.

306 (SAND—77-1992) **Enchanced gas recovery program. Part I. Second annual report, October 1976 through September 1977.** Northrop, D.A.; Schuster, C.L. (Sandia Labs., Albuquerque, NM (USA)). Apr 1978. Contract EY-76-C-04-0789. 90p. Dep. NTIS, PC A05/MF A01.

Massive hydraulic fracture mapping field experiments continued in FY 77 with Sandia participating in fractures with Gas Producing Enterprises, Amoco, Shell, and Conoco. The surface electrical potential system has demonstrated that the fracture orientation can be determined to within +- 5° and has clearly shown that most fractures are asymmetrical. This system has been completely documented and has had wide exposure to the industry providing for the transfer of its technology. Improvements in the electrical system, its analytical model and the development of new systems for fracture diagnostics was also continuing. Hydraulic and explosive fracturing experiments have been conducted adjacent to an existing tunnel complex at DOE's Nevada Test Site and have been directly observed by subsequent mineback activities. Evaluation of a proppant distribution experiment has revealed a very complex fracture system which differed significantly from design; additional in situ stress and material property measurements are being made to quantify observed behavior. An experiment has been designed and conducted which will examine hydraulic fracture behavior at a geologic interface between formations with significantly different moduli, Poisson's ratios and porosities; mineback evaluation will occur next year. In conjunction wth a nuclear containment program, the stresses surrounding a contained explosive detonation have been examined. A 256 lb TNT detonation produced no radial fractures extending from the main cavity, but gases escaping down a borehole did create a 30 x 75 ft fracture in a region of reduced overburden stress caused by the explosion. Specific aid was provided in the planning and development of the Western Tight Gas Sands Project and DOE's Enhanced Gas Recovery Strategy Plan. A resource survey of the Greater Green River Basin was conducted as part of the latter activity.

307 (SAND—78-1172) **Enhanced gas recovery program. First quarterly report: fiscal year 1978, October 1977—December 1977.** Schuster, C.L.; Northrop, D.A. (eds.). (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 87p. Dep. NTIS, PC A04/MF A01.

A diverse series of field experiments were conducted. These included a deep limited entry massive fracture, a shallow tar sand horizontal fracture, a chemical explosive fracture in the Devonian Shale, and an interface experiment of the Nevada Test Site. The deep fracture in Utah was evidently of insignificant length for the fracture orientation to be determined. In the Canadian horizontal fracture, the fracture growth was detected; however, any orientation data was either masked by high telluric currents or by the symmetrical nature of the fracture. A surface seismic array confirmed that the majority of a chemical explosive fracture did detonate. Seismic recordings were also made during the NTS fracture tests and their analysis should reveal fracture phenomenon and locations. With respect to the NTS interface experiment, two hydraulic fractures were created above and below a geologic interface between ashfall tuff and welded tuff formations with significantly different material properties. Complete flow and pressure data were recorded for these fractures which were designed to have 50 ft height and total 600 ft length. Subsequent mineback will focus upon fracture behavior at the formation interface. One fracture has been located by exploratory drilling and mineback plans are being defined. Evaluation of a previously conducted staged proppant experiment at NTS continues with quantitative examination of the in situ stresses in the experiment region. These are being measured by small volume (less than 50 gal) hydraulic fracture tests in boreholes from the tunnel. It is anticipated that these data will aid in the explanation of the complexity of the fracture system observed in the original fracture test.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 277

COMBUSTION

REFER ALSO TO CITATION(S) 557, 564, 565

OIL SHALES AND TAR SANDS

RESERVES AND EXPLORATION

308 (CONF-780825—P2, pp D8.1-D8.10) **Heavy-oil resources of Kansas—Missouri—Oklahoma.** Ebanks, W.J. Jr. (Kansas Geological Survey, Lawrence); James, G.W.; Livingston, N.D.; Wells, J.S.; Roberts, J.F. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1B.

Deposits of heavy-oil bearing Cherokee sandstones in southeastern Kansas and contiguous areas of Missouri and Oklahoma are under investigation. There may be as much as 4 billion barrels of heavy-oil resources present in western Missouri, but the oil occurs in many small, discontinuous deposits at the surface or in the shallow subsurface. Although a resource which may be as large as 200 million barrels of heavy-oil probably is present in the shallow subsurface beneath the three counties studied in Kansas, it too occurs in small, separated areas. Shows of oil were encountered in two of the 16 wells drilled in Oklahoma, but the volume of the oil resource is still undetermined. The main reason for lowering estimates of resource-size is the discontinuity of individual reservoir sandstones. The earlier impression of these heavy-oil saturated, "blanket" sandstones is not correct. The composition, texture, internal structures, and distribution of these sandstones suggest that they were formed by alluvial-deltaic systems extending periodically into Kansas from the east. Some of these extended southward into Oklahoma. The geochemistry of these heavy-oils is best explained as resulting from contact and washing of the sandstones by natural fresh waters, with accompanying alteration of the oils by bacteria. The heavy-oils have almost no light hydrocarbon compounds, have only small amounts of normal paraffins, and have slightly higher contents of sulfur and non-hydrocarbons than do the lighter Cherokee crude oils in the area.

SITE GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 285, 286

SITE GEOLOGY

REFER ALSO TO CITATION(S) 284, 288

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 158, 307, 317

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

REFER ALSO TO CITATION(S) 244, 317

309 (CONF-780825—P2, pp D6.1-D6.16) **Oil recovery from a Utah tar sand deposit by in situ combustion.** Johnson, L.A.; Fahy, L.J.; Thornton, M.W.; Romanowski, L.J. Jr.; Marchant, L.C. (Laramie Energy Research Center, WY). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 1B.

The U.S. tar sand resource consists of an estimated 30 billion barrels (4.7Gm^3) of oil. Most of this resource is in six large deposits in Utah. Through research and development to prove tar sand oil recovery methods, the Department of Energy is attempting to stimulate commercialization of this resource. Two in situ combustion field experiments have been conducted in Utah's Northwest Asphalt Ridge deposit. The second of these experiments, described in detail, was completed in early 1978 and consisted of a reverse combustion preparatory phase followed by a forward combustion production phase. Oil recovery exceeding 20% of the oil-in-place from a 40 ft by 120 ft (12m by 36m) nine-well line pattern provides encouragement for larger scale technical and economic demonstrations. This report includes the following in detail: the design of the oil production process and its related air injection and production facilities; ignition of the process; conduct of the process (for 183 days); effluent monitoring; data acquisition (including use of an on-site minicomputer); data analysis; and resultant conclusions.

310 (FE—2346-25) **Energy from in situ processing of Antrim oil shale. Quarterly technical progress report, January—March 1978.** Humphrey, J.P. (Dow Chemical Co., Midland, MI (USA). Hydrocarbons and Energy Research Dept.). 17 Apr 1978. Contract EX-76-C-01-2346. 45p. (DOW/SRPR—25). Dep. NTIS, PC A03/MF A01.

Activities are reported in a program to test the technical feasibility for the in situ processing of the Antrim oil shale within the Mississippian-Devonian black shale sequence of the Michigan Basin to produce energy values. In situ combustion has been achieved in a well containing coal and charcoal, using a propane burner for ignition. Combustion was maintained at a high level for about a week. Greater quantities of hydrocarbons, carbon monoxide, and hydrogen were produced than during previous trials, and the heating value of the effluent gas was in the 40-60 Btu/scf range. After completion of air injection, the pressure on the injection well was reduced, permitting gases to flow back from the formation. During this period, the gas analysis showed an increased amount of hydrocarbons, possibly reflecting retorting of the oil shale. The initial chemical underreaming experiment was carried out in Dow/ERDA Well No. 201 using 28 percent hydrochloric acid. Logging of the well indicated that enlargement of the cavity had occurred, but the results are still under evaluation. Several wells were drilled in preparation for the explosive underreaming experiments. Shale characterization and resource inventory activities are continuing in four of the major universities of Michigan.

311 **In situ process for recovery of carbonaceous materials from subterranean deposits.** Hoyer, W.A. (to Exxon Production Research Co.). US Patent 4,091,869. 30 May 1978. Filed date 7 Sep 1976. 8p.

A method is disclosed for recovering carbonaceous material from a subterranean deposit such as oil shale. A first zone of the subterranean deposit is heated to liquefy and vaporize carbonaceous materials contained therein. A substantial portion of the carbonaceous materials are removed from this first zone. Thereafter a second zone of the deposit is rubblized such that material of the second zone occupies a portion of the space occupied by the first zone. The second zone is then heated and carbonaceous materials are removed therefrom.

SURFACE METHODS

312 **Fluidized bed retorting of tar sands.** Gifford, P.H. II. (to Phillips Petroleum Co.). US Patent 4,094,767. 13 Jun 1978. Filed date 10 Nov 1976. 10p.

Raw tar sand is treated in a fluidized bed reactor means wherein the raw tar sands are fed into an area below the top of the bed. The bitumen is converted in the process in a reducing atmosphere including steam to produce hot coked sand and hot off-gases. Off-gases from the reactor means pass through a heat exchanger means to preheat fresh (raw) tar sand. The cooled off-gases are separated to recover raw oil, while at least a portion of the separated gases are recycled to the reactor means, to retrieve and retain heat in the system by passing upwardly through hot spent sand. Steam and oxygen are injected into the lower area of the fluid bed in an area above the spent sand zone to burn off coked sand so as to produce heat for the cracking zone.

313 **Separation of bitumen from tar sands using sulfur and water.** Fuller, E.J. (to Exxon Research and Engineering Co.). US Patent 4,094,768. 13 Jun 1978. Filed date 4 Jan 1977. 6p.

A relatively low temperature process for separating and recovering bitumen from natural tar sands wherein granular sulfur and water are mixed with the tar sand, in the presence of air, to form a sulfur-bitumen agglomerate which floats on the water, with relatively bitumen-free sand sinking to the bottom. The agglomerate may be skimmed off the surface of the water and bitumen recovered therefrom by heating the agglomerate to melt the sulfur and then separating the molten sulfur from the hot bitumen. It has unexpectedly been discovered that a yield of over 80% of bitumen can be recovered from the tar sands by the use of sulfur in the process, compared to only about 20% if sulfur is not present.

314 **Formation of coke during thermal hydrocracking of Athabasca bitumen.** Nandi, B.N.; Belinko, K.; Ciavaglia, L.A.; Pruden, B.B. (Dep of Energy, Mines and Resour, Ottawa, Ont). *Fuel;* **57**: No. 5, 265-268(May 1978).

The purpose of this paper is to offer microscopic evidence to support the formation of at least two distinctly different coke structures during thermal hydrocracking of Athabasca bitumen. It was

shown that these cokes form independently of each other and that they correspond to coking of specific fractions of the bitumen. Some correlation between the physical structure of the coke and the chemical structure of individual bitumen fractions is also discussed. 13 refs.

315 Coking of bituminous solids with hot solids recycle. Flynn, P.C. (to Petro-Canada Exploration Inc.). US Patent 4,082,646. 4 Apr 1978. Filed date 17 Jun 1977. 6p.

Coked solids, produced by coking of tar sands, are contacted in a first zone with air and the minimum amount of supplemental fuel needed to burn all the coke. Part of the hot clean mineral solids produced is then discarded; the balance is moved into a second zone. Here supplemental fuel is burned to increase the temperature of the solids. The hot solids from the second zone are recycled to the coking stage. Only part of the solids is heated with supplemental fuel, thereby reducing consumption of the latter. In addition, the flue gas from the second zone is relatively clean and can be vented directly to the atmosphere in the flue gas from the first zone.

REFINING

316 (CONF-780460—3) **Converting Green River shale oil to transportation fuels.** Sullivan, R.F.; Stangeland, B.E. (Chevron Research Co., Richmond, CA (USA)). 1978. Contract EX-76-C-01-2315. 41p. Dep. NTIS, PC A03/MF A01.

From 11. oil shale symposium; Golden, CO, USA (11 Apr 1978).

Shale oils contain significant quantities of nitrogen, oxygen, and heavy metals. Removing these contaminants is a major consideration in the catalytic conversion of shale oil to transportation fuels. Hydrotreating can remove substantially all of these elements, while coking only removes most of the heavy metals. Pilot plant data for three processing schemes were generated during the course of this study: hydrotreating followed by hydrocracking, hydrotreating followed by fluid catalytic cracking, and delayed coking followed by hydrotreating. Yields and product inspections are presented for these three cases.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 415

MARKETING AND ECONOMICS

317 Tar sands: 1973—1976—future. Benn, P.J. (Petroleum Recovery Inst., Calgary, Alberta). *CIM Bull.;* **71**: No. 795, 90-95(Jul 1978).

After reviewing the location, depth and quantity of tar sand reserves in Alberta, the author compares prospects between 1973 and 1976 and between in-situ processing and surface mining and treatment. He concludes: First, reserves will be adequate for a long time to come, no matter how you slice them. Second, all parameters involved in an economic analysis seem to have doubled or tripled except rate of return, which has decreased to the point of being unattractive. Third, if more plants are to be built, then, with respect to in-situ, the first thing that must happen is an improvement in technology so that the recovery of bitumen per unit of heat used increases, and that is what the AOSTRA grants are all about. Also, and this applies to both mining and in-situ, the economic climate must change so that the rates of return can improve and will, in absolute terms, be well ahead of the inflation rate. Finally, the most important, it is too late now for tar sands alone to solve the Canadian problem of non-self-sufficiency in petroleum-derived energy, even if we started to build more plants right now.

ENVIROMENTAL ASPECTS

318 Assessment of plume dispersion parameters measured in fall and winter at a tar-sands refinery complex. Whaley, H.; Lee, G.K. (Dept. of Energy, Mines, and Resources, Ottawa). *J. Air Pollut. Control Assoc.;* **28**: No. 6, 589-593(Jun 1978).

Increased energy processing activity in the north has resulted in a demand for measured data on plume dispersion that is relevant to this particular region. The north was, therefore, selected for study in a comprehensive government/industry research program. The objective of these studies was to assess the behavior of plumes in various geographic areas in Canada. The program utilizes airborne and automobile-mounted probes to determine SO_2 and temperature profiles within stock-emitted plumes as well as meteorological data on local atmospheric structure. The data are then analyzed numerically to obtain plume axis elevations and standard deviations of spread and these results are compared to accepted predictive methods. Good agreement with the analysis of Briggs was observed for predicting the location of the plume axis in neutral conditions; some deviations were noted in stable conditions. Values of the measured product (sigma y-sigma z) were generally larger than those of Pasquill, particularly for those values close to the source. A difference between the measured values of (sigma y-sigma z) in fall and winter was observed in stable conditions.

NUCLEAR FUELS

RESERVES

REFER ALSO TO CITATION(S) 487

319 Uranium behaviour in the process of tectonite formation in zones of abyssal factures. Dmitriev, V.I.; Berezina, L.A.; Sannikova, L.A. *Dokl. Akad. Nauk SSSR;* **232**: No. 1, 209-212(Feb 1977). (In Russian).

The patterns of distribution, concentration and manifestation of uranium and thorium in tectonic formations of different ages, in deep fault zones, have been determined. It has been established that the stage of plastic deformations was not accompanied by a supply of U. The state of brittle deformations, accompanied by an intensive supply of U, is characterized by superimposed U concentrated, primarily, in melanocratic rock-forming minerals, as well as in fissures, in the form of brannerite and pitchblende.

EXPLORATION

REFER ALSO TO CITATION(S) 1370

320 (GJBX—59(78)) **Gross gamma-ray calibration blocks. Part I. Gross gamma-ray calibration blocks; construction. Part II. Gross gamma-ray calibration blocks; grade assignment.** Mathews, M.A.; Kosanke, K.L. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). May 1978. Contract EY-76-C-13-1664. 97p. Dep. NTIS, PC A05/MF A01.

Eleven transportable, portable hand counter or face scanner calibration blocks were constructed from predetermined mixtures of sand, uranium ore, and concrete. These blocks, 42 in. dia. and 17 in. deep, approximate an infinite source, in both the vertical and horizontal directions, for the gamma rays of interest. The grades assigned to these blocks, for the purpose of calibrating portable gross gamma detectors, were determined by a procedure based on a standard least-squares technique for limiting sampling errors.

321 (GJBX—80(78)) **Preliminary study of the uranium favorability of the Jornada Del Muerto Basin and adjacent areas, South Central New Mexico.** Templain, C.J.; Dotterrer, F.E. (Bendix Field Engineering Corp., Grand Junction, CO (USA)). Jun 1978. Contract EY-76-C-13-1664. 28p. Dep. NTIS, PC A03/MF A01.

Data indicate that possible uranium host rocks include the Precambrian rocks, the Ordovician Bat Cave Formation and Cable Canyon Sandstone, the Permian Abo Formation, Lower Cretaceous Dakota Sandstone, and the Upper Cretaceous-lower Tertiary McRae Formation. The Cenozoic sequence contains possible host beds; little is known, however, about its stratigraphy. Secondary uranium mineralization is found associated with faults in the Jornada area. All fault zones there are possible sites for uranium deposition. Possible sources for uranium in the Jornada del Muerto area include uraniferous Precambrian rocks, tuffaceous beds in the McRae Formation, and the Tertiary Datil and Thurman Formations. Hydrothermal solutions may have deposited the veinlike fluorite deposits, of which the purple varieties were found to be radioactive during this study.

322 (K/UR—106) **Hydrogeochemical and stream sediment. Reconnaissance basic data for Iron Mountain NTMS Quadrangle, Michigan; Wisconsin.** (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 22 Jun 1978. Contract W-7405-ENG-26. 130p. (GJBX—97(78)). Dep. NTIS, MF A01.

Portions of document are illegible.

Results of a reconnaissance geochemical survey of the Iron Mountain Quadrangle, Michigan; Wisconsin are reported. Field and laboratory data are presented for 479 groundwater samples, 369 stream sediment samples, and 389 stream water samples. Statistical and areal distributions of uranium and other possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided, and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization are briefly discussed. Results from groundwater, stream sediment,

and stream water samples delineate several areas which appear favorable for possible uranium mineralization within the Iron Mountain Quadrangle. Areas associated with the Wolf River Batholith and the McCaslin units are the most prominent. Other notable areas are present in the northeast and the southwest corners of the quadrangle. Both of these areas are dominated by Precambrian igneous and metamorphic rocks, which are quite variable in composition.

323 Mineral exploration trends and developments in 1977. Hood, P. (Geological Survey of Canada, Ottawa, Ontario). *Can. Min. J.;* **99**: No. 1, 8-9, 11, 13, 16-18, 20, 22, 25-26, 29-30, 32-33, 35, 38-40, 42, 44-45, 47-48, 50, 52-53(Jan 1978).

World developments in mineral exploration are described, with emphasis on techniques and instrumentation for airborne geophysical surveys, data systems, aeromagnetics, geochemical and radiometric methods, and ground survey techniques such as drill-hole logging, electromagnetic methods, geochemical methods, induced polarization, radiation detection, resistivity, and seismic methods.

324 Uranium-containing mineral springs and uranium ore deposits, in the vicinity of Oda-city, Shimane prefecture. Sugiyama, R. (Tokai Univ., Tokyo (Japan)). *Onsen Kagaku;* **28**: No. 3, 109-130(Dec 1977). (In Japanese).

Ikeda radium-containing mineral spring in the vicinity of Oda-city was very famous as the strongest radioactive spring in Japan. In the environs of Ikeda, chemical analysis of uranium contents of some mineral springs were performed, and abundant content of 51 r/l was caught in Kobayashi spring, and in Asahara spring a maximum content reached 68.5 r/l. The locations of these high uranium-containing mineral springs are along the faults, between aplitic granite (Yugakae intrusives) and Asahara beds (Oda formation of middle miocene), or across the basin of Asahara beds. Founding on the results of the intimate relation between Misasa uranium-containing thermal spring and Ningyo-toge type uranium ore deposits in Tottori prefecture, and expecting the existence of uranium ore deposits in the basin of Asahara beds, the investigations near Asahara spring were carried out. And, the method was acquired to find the hidden crops of latent uranium ore deposits lying under-ground, by chemical prospects of uranium-containing mineral springs.

325 Velocity of gamma well logging. Kozynda, Ya.O.; Novikov, G.F.; Sinitsin, A.Ya. (Leningradskii Gornyj Inst. (USSR)). *Izv. Vyssh. Uchebn. Zaved., Geol. Razved.;* No. 4, 137-140(Apr 1977). (In Russian).

For the first time, a theoretical study has been made aimed at optimizing the logging speed under the most complicated conditions in uranium and thorium fields. Speed V depends on tau_1 and tau_2 time constants of the register of the 1st (uranium) and 2nd (thorium) channels of the γ^2-spectrometer, which, in turn, depend on the l and d dimensions of the scintillometer used, ore body thickness h and uranium and thorium concentrations in the ore bodies -qsub(U) and qsub(Th), respectively. The values of tau_1 and tau_2, providing for statistical errors of less than +-10% and calculated for elongated CsI(Na) scintillators of standard and non-standard sizes are tabulated. The obtained results must be taken into account in developing interpretation techniques for computerized γ-spectral logging diagrams.

326 Natural neutron radiation of an inclined radioactive bed in a well. Davydov, Yu.B. *Izv. Vyssh. Uchebn. Zaved., Geol. Razved.;* No. 2, 82-89(Feb 1977). (In Russian).

The problem of transfer of the natural neutron radiation of an active seam, with due account for the angle between the seam and well, is solved by the two-group diffusion approximation method. The measurement geometry and mathematical solution are given for the cases of one-dimensional and random distribution of neutron sources in the seam. The general solution of the problem can serve as an initial expression for analysis of the fission neutron distribution in the most practically significant cases, in particular, in the case of an active seam of finite thickness with uniform mineralization. Considered as an example is the migration of neutrons in a well-seam system in which the apparent thickness of the seam is 2h, the center of the system is at origin, and the source of neutrons is radioactive elements. The calculation results indicate that the configuration of neutron logging curves, in the case of an oblique seam, to a great extent depends on neutron sources in rocks, well diameter r_0, apparent seam thickness, and angle α between the seam and well.

327 Rare alkalies as indicators of deep source of the ore substance (ore deposits of the Okhotsk-Chuckchee volcanic belt are considered for illustration purposes). Portnov, A.M. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Mineral'nogo Syr'ya, Moscow (USSR)). *Dokl. Akad. Nauk SSSR;* **233**: No. 1, 222-225(Jan 1977). (In Russian).

A review of the behaviorial peculiarities of alkaline and radioactive elements in the ore fields of various structure-facies zones of the Okhotsk-Chukotka volcanogenic belt is given. A summary of the data on the distribution of U, Ra, Th, K, Na, Rb, Li and K/Rb in the enclosing rocks and metasomatites of molybdenum and gold fields is presented. The similarity of the wallrock hydrothermal alterations in the fields under consideration manifests itself in a marked accumulation of K in orthoclasites (up to 8-10%) and intensive evaluation of Th at metasomatic alterations of the rocks. The antipathy of Th and K in the orthoclastic zones is a good radioactive geochemical indicator enabling ore fields to be distinguished from air, during aeroprospecting for Au, Ag and Mo, with a high degree of accuracy. Examination of the K/Rb ratios indicates that their lower values are adequately correlated with the greater thickness of the "granite" bed and agree with the spatial and structural differentiation of the molybdenum, gold-silver and tin types of mineralization.

FEED PROCESSING

328 Problems raised by corrosion in the nuclear fuel cycle. Tricot, R.; Boutonnet, G.; Perrot, M.; Blum, J.M. (Compagnie de Produits Chimiques et Electrometallurgiques Pechiney-Ugine Kuhlmann, 75 - Paris (France)). *Mater. Tech.;* **8**: No. 9, 605-619(1977). (In French, English).

From 2. Colloquium on special steels and nuclear energy; Paris, France (14 - 15 Dec 1976).

In the uranium ore processing industry, materials which resist both mechanical abrasion and corrosion in an acid medium are required. Different typical cases are examined. For the reprocessing of irradiated fuels, two processes are possible: the conventional wet process, of the Purex type, and the fluoride volatilization process. In the latter case, the problems raised by fluoride corrosion in the presence of fission products is examined. The other parts of the fuel cycle are examined in the same manner.

ENRICHMENT

329 (DOE/EDP—0027) **Environmental Development Plan (EDP): uranium enrichment.** (Department of Energy, Washington, DC (USA)). Jun 1978. 60p. Dep. NTIS, PC A05/MF A01.

This Environmental Development Plan (EDP) identifies and examines the environmental, safety, health, and socioeconomic (ES and H) issues and corresponding requirements associated with the DOE research, development, demonstration, and operation of the Uranium Enrichment program. This EDP is limited to consideration of: (1) the gaseous diffusion process; (2) the centrifuge process; (3) centrifuge rotor fabrication; and (4) related research and development activities.

330 Influence of atomic collisions on the selectivity of resonant excitation in isotope separation. Karlov, N.V.; Krynetskii, B.B.; Mishin, V.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 502-505(Apr 1978).

An analysis is made of interisotope excitation transfer in laser isotope separation. Kinetic equations are applied to estimate the dependence of the excitation selectivity on the density of the atomic vapor in the illuminated zone. Results are presented of experimental investigations for atoms having optical transitions with simple and complex isotopic structures. Measurements are made of the excitation transfer cross section and the possibility of obtaining large quantities of material by laser isotope separation in atomic vapors is demonstrated.

331 Influence of laser radiation on electron capture by molecules. Beterov, I.M.; Chebotaev, V.P.; Fateev, N.V.; Yakovin, D.V. (Institute of Semiconductor Physics, Siberian Branch of the Academy of Sciences of the USSR, Novosibirsk). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 533-534(Apr 1978).

Changes in the concentration of negative ions in the SF_6 gas due to exposure to CO_2 laser radiation were observed experimentally. This effect is attributed to a change in the electron capture coefficient and electron resonance energy. The possibility of utilizing such changes in a laser isotope separation is considered.

CENTRIFUGATION

REFER ALSO TO CITATION(S) 1214

332 (DLR-FB—77-16, pp 49-57) **Three-dimensional flow in the chamber of a gas centrifuge with an installed obstacle. A difference method for the solution of the compressible Navier-Stokes equations.** Elsholz, E. (TECHNISCHE UNIV. BERLIN (GERMANY, F.R.). INST. FUER THERMO- UND FLUIDDYNAMIK). 1977. (In German).

In Contributions to the transport phenomena in fluid mechanics and related fields.

The flow-field in a very fast rotating chamber under the presence of a stationarily installed obstacle is calculated numerically from the complete set of Navier-Stokes-equations. A special differential approximation applied, provides stable and non-oscillating solutions even within the region of very small Ekman-numbers. This type of approximation will be derived and its advantages are discussed. Finally, a numerical result is presented which includes strong radial density gradients and shows very clearly the compressible effects as well as the mechanism of vortex shedding generated by the obstacle.

333 (DLR-FB—77-16, pp 59-63) **Separation power density of gas-dynamical isotope separation processes for the enrichment of ^{235}U in the presence of light additive gases.** Fuhse, W. (DORNIER-SYSTEM G.M.B.H., FRIEDRICHSHAFEN (GERMANY, F.R.)). 1977. (In German).

In Contributions to the transport phenomena in fluid mechanics and related fields.

The separation power density of gasdynamical enrichment processes is evaluated using a different method than COHEN. The new way enables a transparent inclusion of auxilliary gases in the theory of isotope separation. The final formula of the separation power density shows strong similarities to the equations used for binary gas mixtures. This allows for the results abtained on two component mixtures being applied on gasdynamical enrichment processes with more than two components.

334 (DLR-FB—77-16, pp 119-123) **Pure countercurrents in rotating gases.** Haenel, D. (TECHNISCHE HOCHSCHULE AACHEN (GERMANY, F.R.). AERODYNAMISCHES INST.); LANGBEIN, G.M. (URENCO LTD., MARLOW (UK)). 1977. (In German).

In Contributions to the transport phenomena in fluid mechanics and related fields.

Initially it is shown that pure axial flows with constant velocity cannot exist in a tube for a compressible fluid. Then a method is described to analyse pure countercurrents, defined as flows which have no component across velocity inversion surfaces.

335 (DLR-FB—77-16, pp 209-214) **Analytic solution for the enrichment of uranium hexafluoride in long countercurrent centrifuges.** Raetz, E. (URENCO LTD., MARLOW (UK); GESELLSCHAFT FUER CENTRIFUGENTECHNIK M.B.H. (CENTEC), BERGISCH GLADBACH (GERMANY, F.R.)). 1977.

In Contributions to the transport phenomena in fluid mechanics and related fields.

The paper describes an analytic solution for the enrichment and the separative power of long countercurrent centrifuges. Equations to derive optimal operation parameters like feed and feed input height are derived and solved.

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 393

336 **Method to process and to recycle without loss uranium/thorium wastes in the uranium/thorium fuel element production.** Boerner, P.; Isensee, H.J. (to Nuklear-Chemie und -Metallurgie G.m.b.H. (NUKEM), Hanau (Germany, F.R.)). German(FRG) Patent 2,601,902/A/. 28 Jul 1977. 7p. (In German).

The invention deals with a method enabling a recycling of uranium/thorium wastes, without loss and without lengthy uranium/thorium separation, in the form of a stable uranium/thorium solution in the production casting process, and in which there are no side-products causing an additional waste problem. According to the invention, the uranium/thorium oxide waste product dissolved in a nitric acid/hydrofluoric acid mixture is boiled down until nitrous gases occur, the residue is then diluted in its hot state with water, and finally the pH value of this solution is adjusted to 2.5 to 3.5 with ammonia at temperatures below 40°C. This solution obtained according to the invention can be reduced to heavy metal concentrations of about 300 g/l at pH 3 to 3.5, can be kept for months and is mixable with polyvinyl alcohol. The solution can be adjusted to the desired uranium/thorium ratio of the casting solution by further addition of uranium or thorium.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 328, 369, 646, 762

337 (ARH-F—106) **Ion exchange flowsheet for recovery of cesium from purex sludge supernatant at B Plant.** Carlstrom, R.F. (Atlantic Richfield Hanford Co., Richland, WA (USA)). 29 Apr 1977. Contract EY-76-C-06-2130. 47p. Dep. NTIS, PC A03/MF A01.

Purex Sludge Supernatant (PSS) contains significant amounts of ^{137}Cs left after removal of strontium from fission product bearing Purex wastes. To remove cesium from PSS, an Ion Exchange Recovery system has been set up in Cells 17-21 at B Plant. The cesium that is recovered is stored within B Plant for eventual purification through the Cesium Purification process in Cell 38 and eventual encapsulation and storage in a powdered form at the Waste Encapsulation Storage Facility. Cesium depleted waste streams from the Ion Exchange processes are transferred to underground storage.

338 (DP-MS—78-7) **Measurement of radioactive gaseous effluents from voloxidation and dissolution of spent nuclear fuel.** Stone, J.A.; Johnson, D.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1978. Contract EY-76-C-09-0001. 15p. (CONF-780819—21). Dep. NTIS, PC A02/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Laboratory-scale tests gave data on the release of tritium, ^{14}C, ^{85}Kr, and ^{129}I as radioactive gases from spent nuclear fuels during voloxidation and dissolution. Voloxidation, a proposed reprocessing step, is intended to remove tritium from fuel by oxidation of UO_2 to U_3O_8 prior to dissolution of the fuel with nitric acid. ^{14}C, ^{85}Kr, and ^{129}I may be evolved in both steps. Quantitative data from the tests may be used in designing off-gas treatment processes and equipment. The tests were performed in a shielded cell with a combination voloxidizer-dissolver. With a recirculating off-gas system, tritium and ^{14}C were trapped on molecular sieves; ^{129}I was trapped on silver-exchanged zeolite. ^{85}Kr was measured by online gamma-ray counting. Zircaloy-clad UO_2 fuels from H. B. Robinson-2, Oconee-1, and Saxton reactors, with burnups from approximately 100 to approximately 28,000 MWD/MTHM, were tested. The results confirm that voloxidation released most of the tritium but only small fractions of the ^{14}C, ^{85}Kr, and ^{129}I; the remainder of these radioactive gases evolved when the voloxidized fuels were dissolved. Voloxidation off-gases typically contained >99.8% of the tritium, 17 to 22% of the ^{14}C, 7 to 17% of the ^{85}Kr, and <8% of the ^{129}I. Tritium evolved as HTO, with <0.1% as HT.

339 (DP-MS—78-17) **Characterization of airborne plutonium-bearing particles from a nuclear reprocessing plant.** Sanders, S.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1978. Contract EY-76-C-09-0001. 31p. (CONF-780819—22). Dep. NTIS, PC A02/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The elemental compositions, sizes, structures, and ^{239}Pu contents were determined for 558 plutonium-bearing particles isolated from airborne particles collected at various locations in the exhaust from a nuclear fuel reprocessing facility. These data were compared with data from natural aerosol particles. Most of the collected particles were composed of aggregates of crustal materials. 3.6% of the particles were organic and 1.7% were metallic, viz., iron, chromium, and nickel. High enrichment factors for titanium, manganese, chromium, nickel, zinc, and copper were evidence of the anthropogenic nature of some of the particles. Plutonium contents of most particles were very low (less than one femtocurie of ^{239}Pu). Plutonium concentrations were determined by the fission track counting method. Only one particle contained sufficient plutonium for detection by electron microprobe analysis. This was a 1-μm diameter particle containing 73% PuO_2 by weight (estimated to be 170 fCi of ^{239}Pu) in combination with Fe_2O_3 and mica. The plutonium-bearing particles were generally larger than natural aerosols. The geometric mean diameter of those collected from the mechanical line exhaust point where plutonium is converted to the metal was larger than that of particles collected from the wet cabinet exhaust (12.3 μm vs 4.6 μm). Particles from the mechanical line also contained more plutonium per particle than those from the wet cabinets. The amount of plutonium per particle decreased with the distance of each sampling point from the mechanical line which is considered the major source of plutonium contamination in the reprocessing facility.

340 (GA-A—14838) **HTGR fuel element size reduction system.** Strand, J.B.; Cramer, G.T. (General Atomic Co., San Diego, CA (USA)). Jun 1978. Contract EY-76-C-03-0167-053. 229p. Dep. NTIS, PC A11/MF A01.

Reprocessing of high-temperature gas-cooled reactor fuel requires development of a fuel element size reduction system. This report describes pilot plant testing of crushing equipment designed for this purpose. The test program, the test results, the compatibility of the components, and the requirements for hot reprocessing are discussed.

341 (GA-A—15011) **HTGR fuel recycle development program. Quarterly progress report for the period ending, May 31 1978.** (Gener-

al Atomic Co., San Diego, CA (USA)). Jun 1978. Contract EY-76-C-03-0167-053. 203p. Dep. NTIS, MF A01.

Portions of document are illegible.

The work reported includes the development of unit processes and equipment for reprocessing of High-Temperature Gas-Cooled Reactor (HTGR) fuel, the design and development of an integrated pilot line to demonstrate the head end of HTGR reprocessing using unirradiated fuel materials, and design work in support of Hot Engineering Tests (HET). Work is also described on trade-off studies concerning the required design of facilities and equipment for the large-scale recycle of HTGR fuels in order to guide the development activities for HTGR fuel recycle.

342 (GA-A—15014) **Continuous solvent extraction feed adjustment for HTGR fuel reprocessing. Interim development report.** Olguin, L.J. (General Atomic Co., San Diego, CA (USA)). Jun 1978. Contract EY-76-C-03-0167-053. 49p. Dep. NTIS, PC A03/MF A01.

The two-cycle Acid-Thorex solvent extraction process requires that the feed stream to each thorium cycle be processed to reduce its nitric acid concentration (feed adjustment). This interim development report presents the results of bench-scale and pilot-plant-scale feed adjustment experiments using a continuous mode of operation. An examination of formic acid denitration and fluoride ion volatilization is also included.

343 (ORNL/TM—6266) **Head-end processing studies with mechanically blended $(U,Pu)O_2$ reactor fuels.** Goode, J.H.; Stacy, R.G. (Oak Ridge National Lab., TN (USA)). Jul 1978. Contract W-7405-ENG-26. 83p. $6.00.

Scouting studies were made of the effects of fabrication, irradiation, and voloxidation on the release of fission products and on the nitric acid solubility of three prototype specimens of mechanically blended $(U_{0.8}Pu_{0.2})O_2$ reactor fuels (the specimens were not typical of present-day reactor-grade mixed oxide). Up to 96 percent of the fission product tritium, 53 percent of the krypton, 81 percent of the ^{14}C, 95 percent of the ^{129}I, and 5 percent of the cesium contained in two mixed-oxide specimens obtained from the Nuclear Materials Equipment Corporation were volatilized after voloxidation in air for 4 h at 650°C. The voloxidation, however, increased the amount of plutonium that would not dissolve in nitric acid from 0.02 percent to approximately 2 percent. A stronger, secondary dissolvent, containing fluoride, was necessary in order to dissolve the remaining plutonium in the NUMEC fuels, leaving an insoluble residue of noble metal fission products—ruthenium, molybdenum, technetium, palladium, rhodium, and corrosion products. A fluoride-containing secondary dissolvent might not be necessary if the mixed oxide is manufactured as a true solid solution. The studies also indicated that the lower-temperature UO_2 axial blanket of the NUMEC rods contained up to 100 times more tritium per gram of fuel than in the higher-temperature $(U,Pu)O_2$ core. Irradiation to 10.7 at. percent in EBR-II did not render the plutonia in a vibratorily compacted $(U_{0.8}Pu_{0.2})O_2$ fuel rod that had been fabricated at Argonne National Laboratory completely soluble in nitric acid; 3.75 percent of the plutonium remained after three 2-h leaches in 8 M HNO_3. Since the fuel contained discrete PuO_2 particles prior to irradiation, it may be concluded that long-term irradiations at high linear heat ratings cannot be relied upon to eliminate the use of a fluoride-containing secondary dissolvent to dissolve all of the plutonium. 30 tables, 23 figs.

344 (ORNL/TM—6393) **Instrumentation and control development and design philosophy for Advanced Fuel Recycle.** Hamel, W.R.; Bradley, N.C.; Jansen, J.M. Jr. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 39p. AT.

This document provides a definition and an explanation of the instrumentation and controls philosophy being utilized in the Advanced Fuel Recycle Program (AFRP). The general objectives and assumptions used in defining the philosophy are based on overall AFRP objectives. The philosophy presents architectural concepts, functional capabilities, performance requirements, safeguards factors, and implementation techniques. A brief summary of current development activities is also presented.

345 **Parker report on the British reprocessing plant at Windscale.** Parker, J. *Atomwirtsch., Atomtech.;* **23**: No. 5, 250-252(May 1978). (In German).

The British minister of the environment ordered at the beginning of 1977 a public hearing to be held in connection with the extension of the British Nuclear Fuel's (BNFL) reprocessing plant at Windscale by a new plant for oxidic fuel elements. The hearing lasted from the middle of June until October 1977. It aroused worldwide interest on account of the procedure (witnesses for the applicant and for the opponents were cross-examined by independent solicitors in front of an independent judge, and had to give evidence under oath) and on account of the fact that the investigation was not restricted to questions concerning risk and environment, the plant itself, the site and the reprocessing procedure, but also dealt with the fundamental question whether there would be any need for reprocessing at all. The results are published in a three-volume report. This is a German translation of chapter 17, the summary of the main conclusions and recommendations.

346 **Waste disposal of nuclear power plants.** Hildenbrand, G. (Kraftwerk Union A.G., Erlangen (Germany, F.R.). Bereich Brennelemente, Brennstoffkreislauf). *Siemens-Z.;* **52**: No. 4, 160-165(Apr 1978). (In German).

The problem of waste disposal of nuclear power plants is discussed. The radioactive materials produced in operation and waste disposal of nuclear power plants and the single steps of the disposal (intermediate storage in the nuclear power plant, transport to further processing of the spent fuel elements, intermediate storage in the reprocessing plant, processing, conditioning of the radioactive wastes and the final storage in salt mines in detail) are individually described.

347 **Hot cell for the reprocessing of spent fuel samples.** Higgy, H.R. (Atomic Energy Establishment, Cairo (Egypt)). *Ann. Nucl. Energy;* **5**: No. 1, 1-4(1978).

A hot cell for the reprocessing of spent fuel samples is proposed for the process hall of the radiochemical laboratory at Inchas. The design permits for safe handling of spent fuel samples with radioactivity level up to 10,000 MeV-Ci. The hot cell consists of an air-tight stainless steel box 2 x 1.5 x 1.75 m^3,surrounded by suitable biological shielding, and equipped with master-slave manipulators, lead glass window, and a number of gloves. The box is connected with a solid-waste disposal mechanism, and a feeding shute for transferring the spent fuel samples into the hot cell. The cell is provided with a sliding door through which the stainless steel box can be easily withdrawn for maintenance or replacement. The ventilation of the hot cell ensures non-radioactivity release in the surrounding zones.

348 **Process for separating radioactive krypton and xenon from the off-gases from nuclear reprocessing facilities or nuclear reactors.** Glatthaar, R.; Lehmer, W. (to Linde A.G., Wiesbaden (Germany, F.R.)). German(FRG) Patent 2,611,833/A/. 22 Sep 1977. 13p. (In German).

The invention concerns a process for separating the noble gases krypton and xenon, which contain radioactive isotopes, form the off-gases which form during the reprocessing of fuels or in connection with nuclear reactors. The off-gases contain, besides other components, nitrogen and argon as carrier gases, whereby the off-gas, the other components having been separated, is cooled off and the krypton removed by distillation.

349 **Recovery of cesium and palladium from nuclear reactor fuel processing wastes.** Campbell, D.O. (to Energy Research and Development Administration, Washington, D.C. (USA)). German(FRG) Patent 2,635,482/A/. 3 Mar 1977. 10p. (In German).

After separation of the fissionable materials from the nitric acid solution of the spent fuel in the first extraction cycle of the nuclear fuel reprocessing valuable metals in recoverable amounts remain in the fission product waste solution as well as useful radioisotopes. The method suggested here shows a way of isolating cesium (particularly Cs 137) together with palladium in a single precipitation step from the waste solution. Firstly Pd(II) is converted to Pd(IV) electrolytically. By adding chloride ions, both elements are precipitated out as Cs_2PdCl_6. It is not necessary to adjust the pH value as opposed to other recovery methods of metal values, so there is nothing to prevent a recovery or readdition of nitric acid in the extraction process. The method is demonstrated by means of simulated waste solution.

350 **Chemical industry and process technology in nuclear fuel reprocessing.** Baumgaertner, F. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Heisse Chemie). *Chem. Ind. (Duesseldorf);* **100**: No. 10, 684-694(1977). (In German).

The article describes the chemical and engineering tasks in nuclear fuel reprocessing, the state of technology in the Federal Republic, and the outstanding development tasks. The principle of the purex process to separate the valuable fissionable materials uranium and plutonium from the highly active fission products which are not further used is explained. Special attention is paid to the more recent developments regarding the minimization of emissions and wastes, in which the krypton retention in the waste gas as well as the tritium concentration and use of electrochemical methods to reduce the salt content of waste solutions are described as examples. Continuous operation optimization and the determination of plant expansion factors are important development tasks directed at the demand of the large German reprocessing plant under planning. Furthermore, chemical research work is also essential which enables the better understanding of the molecular processes between the numerous chemical species in the extraction system and which could be the basis of avoiding or removing process disturbances.

351 Absolute Sicherheit oder verbrannte Erde. Der Kampf gegen das Atommuell-Zentrum im Emsland. (Absolute safety or scorched earth. The fight against the nuclear waste center in the Ems region). Dreyer, G.; Vinke, H. Hamburg, Germany, F.R.; Verl. Association (1977). 125p. (In German).

Compilation of actions by Buerger initiatives against three planned sites for a nuclear fuel center in the Ems region. (Comment: In the meantime it is planned to have Gorleben as the site for this center).

352 Graphical and experimental determination of uranium, nitric acid, plutonium and some fission products in an LMOM2 extractor in modified scheme of the first extraction in the Purex process. Poczynajlo, A.; Hoffmann, P.M.; Zolnierczuk, M. (Institute of Nuclear Research, Warsaw (Poland)). *Nukleonika;* **22**: No. 8, 665-680(1977).

For the selective separation of uranium from plutonium and fission products, the low acid extraction flowsheet has been proposed which was then proved on a countercurrent 16-stage laboratory extractor of mixer-settler type. Experimentally obtained distribution of macrocomponent concentrations (U, HNO_3) agreed well with the distribution predicted on the base of McCabe-Thiele diagrams. Above 99% of plutonium, reduced with the help of iron(2), was found in the raffinate. The decontamination of uranium from Zr, Nb and Ru was lower, compared with plutonium. The concentration of ruthenium and plutonium in the extractor was observed. Accumulation of plutonium is not dangerous as concerns criticality, for spent fuels from thermal reactors.

353 Process for the recovery of actinides. Bruns, L.E.; Martin, E.C. (to Energy Research and Development Administration, Washington, D.C. (USA)). French Patent 2,310,968/A/. 12 May 1976. Priority date 15 May 1975, United States of America (USA). 12p. (In French).

This invention concerns a process for improving the extraction of plutonium with tributylphosphate. It particularly concerns a process for improving the rate at which the plutonium atoms may be extracted from an organic solution in an aqueous solution by removing the radiolytic decomposition products of the tributylphosphate which would otherwise form complexes and non-separable plutonium precipitates.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 1166

354 (BNWL—2260-6) **Study of plutonium oxide leak rates from shipping containers. Quarterly progress report, 1 January 1978—31 March 1978.** (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1978. Contract EY-76-C-06-1830. 32p. Dep. NTIS, PC A03/MF A01.

Progress to date is summarized on five tasks: (1) review literature and theoretical work relating to transmission of particles through channels, (2) investigate the relationship of gas flow rates, leak geometries, pressure, and temperatures, (3) measure transmission of a well characterized simulant (UO_2 powder) through leaks, (4) measure fuel grade PuO_2 leaks through a standard leak, and (5) investigate PuO_2 leaks through simulated and defected containers.

355 (BNWL-SA—6378) **Current perceptions of spent nuclear fuel behavior in water pool storage.** Johnson, A.B. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1977. Contract EY-76-C-06-1830. 5p. (CONF-771109—108). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

A survey was conducted of a cross section of U.S. and Canadian fuel storage pool operators to define the spent fuel behavior and to establish the range of pool storage environments. There is no evidence for significant corrosion degradation. Fuel handling causes only minimal damage. Most fuel bundles with defects generally are stored without special procedures. Successful fuel storage up to 18 years with benign water chemistry has been demonstrated. 2 tables. (DLC)

356 (SAND—78-1262) **Surveillance instrumentation for spent-fuel safeguards.** McKenzie, J.M.; Holmes, J.P.; Gillman, L.K.; Schmitz, J.A.; McDaniel, P.J. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 26p. (CONF-780606—19). Dep. NTIS, PC A03/MF A01.

From Institute of Nuclear Materials Management meeting; Cincinnati, OH, USA (27 Jun 1978).

Portions of document are illegible.

The movement, in a facility, of spent reactor fuel may be tracked using simple instrumentation together with a real time unfolding algorithm. Experimental measurements, from multiple radiation monitors and crane weight and position monitors, were obtained during spent fuel movements at the G.E. Morris Spent-Fuel Storage Facility. These data and a preliminary version of an unfolding algorithm were used to estimate the position of the centroid and the magnitude of the spent fuel radiation source. Spatial location was estimated to +-1.5 m and source magnitude to +-10% of their true values. Application of this surveillance instrumentation to spent-fuel safeguards is discussed.

357 Emergency planning and the transportation of irradiated nuclear fuel in Canada. McLean, D.R.; SEYMOUR, C.G.; WEEKS, J.L. (ATOMIC ENERGY OF CANADA LTD., PINAWA, MANITOBA. WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT). pp 219-234 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977).

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

An accident during the movement of irradiated fuel differs from any other transportation accident only to the extent that a radiation hazard may exist. It follows that an emergency response plan for this type of accident will be similar to any other transportation emergency response plan except that provision must be made for early radiological assessment at the scene of an accident, for the management of radiation injuries and for the clean-up of radioactive contamination if this is found to be present. During the past twenty years, irradiated nuclear fuel has been transported on a small scale in Canada. The numbers of such shipments will increase during the next twenty-five years and thought has been given to the augmented emergency response planning which will be necessary. World experience indicates that the release of radioactivity is an unlikely result of an accident involving the shipment of irradiated fuel. It is, however, necessary to consider the actions to be taken if such an event should occur. These actions relate to the management of casualties, the assessment of radiation and contamination, the restoration of normal traffic and final decontamination. Planning is discussed in the contexts of the Canadian nuclear power program and the Canadian transportation system. It is concluded that an accident of the type described could produce logistic problems but that these are amenable to solution by suitable advance planning.

WASTE MANAGEMENT

358 (BNL-NUREG—50763) **Properties of radioactive wastes and waste containers. Progress report No. 5, April—June 1977.** Colombo, P.; Neilson, R.M. Jr. (Brookhaven National Lab., Upton, NY (USA)). Nov 1977. Contract EY-76-C-02-0016. 49p. Dep. NTIS, PC A03/MF A01.

Portland type II cement decontamination factors for free standing water were determined to be 1, 11, and 200 for ^{137}Cs, ^{85}Sr, and ^{60}Co respectively, indicating ion exchange processes occurring within the cement matrix. The quantity of organic carbon that could be removed from solidification agent matrix materials on leaching in distilled water was measured. No organic carbon was present in the portland type II cement leachant water after ten days while 3.4 ppM, 34.2 ppM, and 9500 ppM organic carbon were present respectively in the bitumen, Dow polymer and urea-formaldehyde leachant water (300 ml). The compression strengths of portland type II cement and urea-formaldehyde waste forms containing various simulated wastes were measured. The effect of the waste/cement ratio on the compression strength of portland type II cement simulated waste forms was also studied. The gamma radiation shielding characteristics of portland cement, urea-formaldehyde, and bitumen waste forms were studied in reference to the maximum incorporated activity permissible in 55 gallon waste packages for transportation in "non-exclusive use" vehicles under 49CFR173. Thermal conductivity, specific heat, and thermal diffusivity values were obtained for portland cement, urea-formaldehyde, bitumen, and Dow polymer waste forms. Solidification verification studies were initiated for the Dow polymer at waste/binder ratios representative of those proposed for use by the vendor. Successful solidifications were obtained for all waste types tested with the exception of 12 wt.% boric acid. The 12 wt.% boric acid waste was successfully solidified after a proprietary pretreatment of the waste stream.

359 (PNL-SA—7072) **Management of high-level nuclear wastes.** Platt, A.M.; McElroy, J.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1978. Contract EY-76-C-06-1830. 28p. (CONF-780904—2). Dep. NTIS, PC A03/MF A01.

From 2. Pacific Basin conference; Tokyo, Japan (24 Sep 1978).

A brief review is given of significant developments in the management of high-level nuclear wastes since the Oct. 1976 first Pacific Basin Conference on Nuclear Power Development and the Fuel Cycle. Emphasis is on policy and technical developments in the U.S., with some attention paid to developments in other countries that have impacted technical direction in the U.S. Spent fuel and its

packaging, vitrification, high-level waste glasses, and repositories are discussed. It is concluded that predisposal technology for processing high-level wastes is well developed and that geologic media can be used for disposal of nuclear wastes without significant risk. 19 figures. (DLC)

WASTE PROCESSING

REFER ALSO TO CITATION(S) 336, 338, 348, 349, 351, 373

360 (ANL—78-19) **Review of metal-matrix encapsulation of solidified radioactive high-level waste.** Jardine, L.J.; Steindler, M.J. (Argonne National Lab., IL (USA)). May 1978. Contract W-31-109-ENG-38. 129p. Dep. NTIS, PC A07/MF A01.

Literature describing previous and current work on the encapsulation of solidified high-level waste forms in a metal matrix was reviewed. Encapsulation of either stabilized calcine pellets or glass beads in alloys by casting techniques was concluded to be the most developed and direct approach to fabricating solid metal-matrix waste forms. Further characterizations of the physical and chemical properties of metal-matrix waste forms are still needed to assess the net attributes of metal-encapsulation alternatives. Steady-state heat transfer properties of waste canisters in air and water environments were calculated for four reference waste forms: (1) calcine, (2) glass monoliths, (3) metal-encapsulated calcine, and (4) metal-encapsulated glass beads. A set of criteria for the maximum allowable canister centerline and surface temperatures and heat generation rates per canister at the time of shipment to a Federal repository was assumed, and comparisons were made between canisters of these reference waste forms of the shortest time after reactor discharge that canisters could be filled and the subsequent "interim" storage times prior to shipment to a Federal repository for various canister diameters and waste ages. A reference conceptual flowsheet based on existing or developing technology for encapsulation of stabilized calcine pellets is discussed. Conclusions and recommendations are presented.

361 (CONF-780819—12) **New wste calcining facility process off-gas filtration system and remote in-place DOP test.** Loo, H.H.; Smith, R.R.; Bingham, G.E.; Allan, T.T.; Wilcox, D.E. (Allied Chemical Corp., Idaho Falls, ID (USA). Idaho Chemical Programs - Operations Office; Flanders Filters, Inc., Burlingame, CA (USA)). 1978. Contract EY-76-C-07-1570. 19p. Dep. NTIS, PC A02/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The crabtrap, one component of a remotely-operable, experimental, in-place DOP test system for process off-gas HEPA filters being developed at Flanders Filters was tested with good results. The crabtrap is a device which is positioned downstream of a HEPA filter during in-place DOP testing to thoroughly mix and collect the air and DOP passing through the filter so the efficiency of the filter and the integrity of the supporting framework can be determined from outside the ventilating system. Concurrently, a test program was also initiated at the Remote Maintenance Development Facility located in the Idaho National Engineering Laboratory. The objective of the effort was to verify that a remotely operable and maintainable (by a single-arm manipulator) off-gas filtration system could be designed for use in the New Waste Calcining Facility being built at the Idaho Chemical Processing Plant. The capabilities demonstrated in the program included the remote replacement of filters, filter housing doors, seals, the filter support and elevating units, and remotely testing the filters using DOP aerosol within a space-limited plenum.

362 (HEDL-SA—1424) **Acid digestion and pressurization control in combustible radwaste treatment.** Allen, C.R.; Cowan, R.G.; Grelecki, C.J. (Hanford Engineering Development Lab., Richland, WA (USA)). 1978. Contract EY-76-C-14-2170. 20p. (CONF-780609—16). Dep. NTIS, PC A02/MF A01.

From ASME/CSME pressure vessels and piping conference; Montreal, Canada (25 Jun 1978).

Acid digestion has been developed to reduce the volume of combustible nuclear waste materials, while converting them to an inert, noncombustible residue. A 100 kg/day test unit has recently been constructed to process radioactively contaminated combustible wastes. The unit, called the Radioactive Acid Digestion Test Unit (RADTU) was completed in September, 1977, and is currently undergoing nonradioactive shakedown tests. Radioactive operation is expected in May, 1978. Because of uncertainties in waste composition and reactivity, the system was required to contain pressurizations. This led to the development of a simple and inexpensive system, which is capable of attenuating a shock wave from a full scale vapor detonation. The system has potential application in a wide spectrum of chemical reactors, since the fabrication materials are resistant to a very wide range of corrosive chemical attack.

363 (ICP—1157) **Removal of particulate solids from the off-gas of the WCF and NWCF.** (Allied Chemical Corp., Idaho Falls, ID (USA). Idaho Chemical Programs - Operations Office). Jun 1978. Contract EY-76-C-07-1540. 49p. Dep. NTIS, PC A03/MF A01.

The design of the system to remove particulate solids from the off-gas of the NWCF is based on the successful operation of the WCF off-gas system. This report summarizes the WCF operating experience on the removal of particles from the off-gas, the pilot-plant tests, and the literature reviews which have contributed to the design of the NWCF off-gas system.

364 (ICP—1158) **Particle growth and control during calcination.** (Allied Chemical Corp., Idaho Falls, ID (USA). Idaho Chemical Programs - Operations Office). Jul 1978. Contract EY-76-C-07-1540. 34p. Dep. NTIS, PC A03/MF A01.

The success of any new process cannot be assured without some knowledge of the fundamentals associated with the process. This report describes studies conducted in a fluidized-bed calciner to determine: (1) particle growth and size distribution, (2) the amount of fines generated by the feed nozzle(s) due to spray drying and attrition, and (3) some of the physical properties of the calcined product and their effects on the process.

365 (KFK—2535) **Solidification of radioactive wastes by means of inorganic binders (literature survey).** Rudolph, G.; KOESTER, R. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. zur Behandlung Radioaktiver Abfaelle; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung). Nov 1977. 44p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

A survey is given on the solidification of radioactive waste solutions, sludges, and tritium wastes by means of cement and other inorganic binder materials. A general outline of the possibilities mentioned in the literature is followed by a somewhat more detailed description, supplemented by personal information, of the works in four research establishments in the United States, i.e. Oak Ridge National Laboratory, Savannah River Laboratory, Brookhaven National Laboratory, Atlantic Richfield Hanford Company. In further sections, the experiences with the various types of cement and the possibilities to improve the solidified products by previous fixation of the toxic nuclides (conversion to insoluble products or absorption) are described; also a post-treatment by polymer impregnation is possible. Finally, definition and determination of leachability are discussed and some results compiled.

366 (MLM—2545(OP)) **Volume reduction of low-level, combustible, transuranic waste at Mound Facility.** Bond, W.H.; Doty, J.W.; Koenst, J.W. Jr.; Luthy, D.F. (Mound Lab., Miamisburg, OH (USA)). [nd]. Contract EY-76-C-04-0053. 20p. (CONF-780819—17). Dep. NTIS, PC A02/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Low-level combustible waste (<100 nCi per g of waste) generated during plutonium-238 processing is collected and stored in 55-gallon (200-liter) drums. The composition of this waste is approximately 32 wt % paper, 46% plastic, 16% rubber and cloth, and 6% metal. Treatment of this waste is initiated by burning in the Mound Cyclone Incinerator, which consists of a burning chamber, deluge tank, venturi scrubber and blower. During the two years of operating the Cyclone Incinerator, experiments have been performed on particle distribution throughout the system using various mixtures of feed material. Measurements were taken at the incinerator outlet, after the spray tank, and after the venturi scrubber. An average emission of 0.23 g of particles per kg of feed at the venturi outlet was determined. The distribution of chlorine from the combustion of polyvinyl chloride was studied. Analyses of the off-gas and scrubber solution show that approximately 75 wt % of the chlorine was captured by the scrubber solution and approximately 17 wt % remained in the off-gas after the venturi scrubber. Measurements of the amount of NO/sub chi/ present in the off-gas were also made during the chloride studies. An average of approximately 200 ppM NO/sub chi/ was produced during each incineration run. Immobilization of the incinerator ash is being studied with regard to long-term behavior of the product. The immobilization matrix which looks most promising is ash mixed with Portland 1A cement in a 65/35 wt % ash-to-cement ratio. This matrix exhibits good mechanical properties while maintaining a maximum volume reduction.

367 (PNL—2654) **Review of radioactive waste immobilization in concrete.** Lokken, R.O. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1978. Contract EY-76-C-06-1830. 112p. Dep. NTIS, PC A06/MF A01.

A discussion is given of properties of concrete waste forms, as obtained through research on immobilization of radioactive wastes in concrete. Types of radioactive waste discussed include low-level and intermediate-level radioactive waste, simulated defense high-level waste sludges and calcines, simulated neutralized AGNS acid fuel reprocessing waste and simulated power reactor fuel cycle HLW

calcines. The waste form properties include water/cement ratio, set times, curing exotherms, compressive strength, impact strength, Sr/Cs/ transuranics leachabilities, thermal conductivity, thermal stability, and radiation stability. A discussion is also given of the conditions and restrictions that govern the feasibility of immobilizing HLW in concrete. Results of theoretical calculations are discussed and illustrated, as are the effects of waste loading on material requirements. Properties of glass and concrete waste forms and of hot-pressed cement used for the solidification are compared. A conceptual process for HLW immobilization in concrete is discussed with emphasis on processing problems associated with heat and radiation effects on water. Use of hydraulic cements for the solidification of low heat generating wastes will produce a product with acceptable properties; the high heat generating rates and radioactivity of HLW makes feasibility assessment difficult. Hot-pressed cement may make HLW immobilization feasible. 27 tables, 21 figures, 70 references. (DLC)

368 (SAND—78-0710) **Use of titanates in decontamination of defense waste.** Dosch, R.G. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 64p. Dep. NTIS, PC A04/MF A01.

Sodium titanate, an inorganic ion exchange material, has been evaluated for use in a process to remove strontium from Defense Waste or other high-sodium, caustic solutions. Distribution coefficients on the order of 10^5 were observed at sub part per million concentrations of Sr, and the effects of other cation impurities and complexants in the waste were investigated. The preparation and general chemical properties of the exchange material are discussed. This information was used in developing a commercial source which has since supplied a 200 kg batch of the material for evaluation. In column ion exchange experiments with ^{85}Sr-doped simulated waste, decontamination factors of 500 or greater were observed in the first 2000 to 3500 bed volumes of effluent, depending on the impurities in the simulant. A -40 to +130 mesh range of sodium titanate powder was used as the baseline material, but a study to produce alternate forms of the titanate was carried in parallel. This has resulted in two materials which appear promising with respect to both simplification of handling and chemical properties. One of the materials is an agglomerated form of the titanate formed by extrusion pelletizing using water as a binder, and the second is a macroreticular organic anion resin which was loaded with 30 to 40% (by weight) of sodium titanate. The results of initial testing of these materials are discussed.

369 **Current status of the technology of separation of transuranium and individual fission product elements from highly active solutions.** Gorski, B.; Pfrepper, G. (Akademie der Wissenschaften der DDR, Leipzig. Zentralinstitut fuer Isotopen- und Strahlenforschung); Heyne, W.; Nebel, D. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). *Isotopenpraxis;* **14**: No. 5, 137-146(May 1978). (In German).

The problem of wastes resulting from reprocessing of irradiated nuclear fuel is considered. Existing technologies of separating various fission products as well as Np, Am and Cm from highly of active waste solutions are surveyed. A possible technological pattern of extracting individual fission products and transplutonium elements is presented.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 355, 833, 1418, 1579

370 (BNL-NUREG—50695) **Evaluation of isotope migration--land bural. Water chemistry at commercially operated low-level radioactive waste disposal sites. Quarterly progress report, January—March 1977.** Colombo, P.; Weiss, A.J.; Francis, A.J. (Brookhaven National Lab., Upton, NY (USA)). Aug 1977. Contract EY-76-C-02-0016. 23p. Dep. NTIS, PC A02/MF A01.

Water samples were collected from ten trenches at the Maxey Flats (Morehead), Kentucky, disposal site in September 1976. Precautions were taken to collect and process the samples under anoxic conditions in accordance with procedures developed for this purpose at Brookhaven National Laboratory. The methods used for the preparation of samples and the analytical techniques employed for inorganic and radiochemical analyses are described. Analytical results of the dissolved radiochemical constituents indicate that all trench water samples contain tritium, strontium-90, and plutonium isotopes. Cobalt-60 and cesium-137 were also detected in most trench water samples. The concentrations of the dissolved inorganic and radiochemical constituents are tabulated for each trench.

371 (BNL-NUREG—50774) **Properties of radioactive wastes and waste containers. Progress report No. 6, July—September 1977.** Colombo, P.; Neison, R.M. Jr. (Brookhaven National Lab., Upton, NY (USA)). Jan 1978. Contract EY-76-C-02-0016. 47p. Dep. NTIS, PC A03/MF A01.

A survey was made of the available literature on the corrosion of steels in soil environments. The effect of the physical and chemical properties of the soil on the rate and type of corrosion of steels has been evaluated. The corrosion rates of ferrous alloys are influenced primarily by the soil environment; alloy compositional and microstructural considerations are secondary. However, as the steel is made more resistant to uniform corrosion it becomes more susceptible to pitting corrosion. The various tests and criteria proposed to measure the corrosiveness of soil are reviewed. 7 tables, 9 figures, 17 references.

372 (BNWL-SA—6310) **Safety assessment and geosphere transport methodology for the geologic isolation of nuclear waste materials.** Burkholder, H.C.; Stottlemyre, J.A..; Raymond, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1977. Contract EY-76-C-06-1830. 16p. (CONF-770565—5). Dep. NTIS, PC A02/MF A01.

From Workshop on risk analysis and geologic modelling; Ispra, Italy (23 May 1977).

As part of the National Waste Terminal Storage Program in the United States, the Waste Isolation Safety Assessment Program (WISAP) is underway to develop and demonstrate the methods and obtain the data necessary to assess the safety of geologic isolation repositories and to communicate the assessment results to the public. This paper reviews past analysis efforts, discusses the WISAP technical approach to the problem, and points out areas where work is needed. The computer code GETOUT II, which models the nuclide transport in geologic media, is described. (DLC)

373 (BNWL-SA—6382) **Glass waste forms for radioactive waste containment.** Ross, W.A.; Mendel, J.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1977. Contract EY-76-C-06-1830. 30p. (CONF-771102—28). Dep. NTIS, PC A03/MF A01.

From 20. annual AICHE meeting; New York, NY, USA (13 Nov 1977).

Glass appears to be a promising medium for storing and disposing of high-level radioactive waste. The waste can be readily vitrified into a chemically durable material that appears to be resistant to potential changes caused by the self-heating nature and the contained radioactivity of the waste. Investigations are continuing but the evidence to date indicates that the vitrified product is a highly stable material well-suited for geologic isolation. 15 figures, 3 tables.

374 (ORNL/TM—6458) **Criticality analysis of aggregations of actinides from commerical nuclear waste in geological storage.** Allen, E.J. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 158p. Dep. NTIS, PC A08/MF A01.

An underground nuclear-waste terminal-storage facility for either spent fuel elements or high level waste from a reprocessing plant will contain large amounts of fissionable actinides. Such a facility must be designed to preclude the concentration of these isotopes into a critical mass. Information on the critical masses of the various isotopes present in spent fuel or high level waste is required as part of such a design effort. This study provides this information. The results of this study will be used, in conjunction with geologic transport rates of the actinide compounds, to estimate mass formation probabilities in waste repositories. A computational model was developed as part of the study to perform criticality calculations rapidly and efficiently and to produce tables and plots of actinide concentration in geologic material versus critical mass. The criticality model uses a discrete ordinates approximation to neutron transport theory and treats six energy groups and spherical geometry. Neutron cross sections were obtained from ENDF/B-IV or ENDF/B-V cross section libraries. Critical masses calculated with the computational model were checked against experimental values and against more detailed calculational values and were found to be from 30 percent less to 10 percent greater. Critical mass calculations were made for five waste types, five waste ages, five actinide elements, and four geologic compositions. Minimum critical masses were calculated for over 400 combinations of the above variables. The relative importance for criticality of the various actinides and waste types is presented in terms of the number of possible critical masses per waste container.

375 (RHO-LD—37) **Hanford long-term high-level waste management program overview.** Reep, I.E. (Atomics International Div., Richland, WA (USA). Rockwell Hanford Operations). May 1978. Contract EY-77-C-06-1030. 53p. Dep. NTIS, PC A04/MF A01.

The objective is the long-term disposition of the defense high-level radioactive waste which will remain upon completion of the interim waste management program in the mid-1980s, plus any additional high-level defense waste resulting from the future operation of N Reactor and the Purex Plant. The high-level radioactive waste which will exist in the mid-1980s and is addressed by this plan consists of approximately 3,300,000 ft^3 of damp salt cake stored in single-shell and double-shell waste tanks, 1,500,000 ft^3 of damp sludge stored in single-shell and double-shell waste tanks, 11,000,000

gallons of residual liquor stored in double-shell waste tanks, 3,000,000 gallons of liquid wastes stored in double-shell waste tanks awaiting solidification, and 2,900 capsules of ^{90}SR and ^{137}Cs compounds stored in water basins. Final quantities of waste may be 5 to 10% greater, depending on the future operation of N Reactor and the Purex Plant and the application of waste treatment techniques currently under study to reduce the inventory of residual liquor. In this report, the high-level radioactive waste addressed by this plan is briefly described, the major alternatives and strategies for long-term waste management are discussed, and a description of the long-term high-level waste management program is presented. Separate plans are being prepared for the long-term management of radioactive wastes which exist in other forms. 14 figures.

376 (SAND—78-1122) **Forced-air cooling of a WIPP mine drift.** Boyd, R.D. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 39p. Dep. NTIS, PC A03/MF A01.

A one-dimensional model has been developed to predict the time, t^*, required to cool a Waste Isolation Pilot Plant (WIPP) mine drift. Comparisons have been made with a two-dimensional model and are found to be in good agreement for four months less than or equal to t^* less than or equal to two years. If the mean roughness of the WIPP mine surface is greater than $^1/_8$ inch, the mine floor can be cooled to 120°F in less than one year, depending on the time after waste emplacement at which mine ventilation commences. 11 figures.

377 (SAND—78-1275) **Seabed waste disposal program: one-dimensional hole closure simulations.** Dawson, P.R.; Chavez, P.F. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 57p. Dep. NTIS, PC A04/MF A01.

One-dimensional hole closure simulations have been performed to determine the effect of different constitutive models and assumed boundary conditions on the predicted rebound behavior of ocean sediments following penetrometer emplacement. It has been found that the type of yield criterion and the post yield behavior strongly influence the ability of sediment to reform a barrier behind a penetrometer. Elastic moduli, density, and overburden affect the rebound, but to a lesser degree than the yield criterion and post yielding response. Further, varying the imposed displacement constraints at assumed sediment boundaries can change the qualitative behavior of the cavity response.

378 (Y/OWI/SUB—76/16531) **Preliminary geologic site selection factors for the National Waste Terminal Storage Program.** (Union Carbide Corp., Oak Ridge, TN (USA). Office of Waste Isolation). Jun 1977. Contract W-7405-ENG-26. 64p. Dep. NTIS, PC A04/MF A01.

The geologic considerations and the associated factors that have to be addressed in the selection of repository sites in deep geologic formations are listed and described. In addition a description is given of the information necessary to assess the geologic factors. The methods of obtaining this information are described. An illustration is given of a general approach of how the geologic factors could be applied and integrated to assess the acceptability of candidate sites. No consideration is given to a detailed description of the application of integration of the geologic factors. The criteria associated with each factor that will be used are not defined. (JSR)

379 (Y/OWI/SUB—77/22334) **Proposed quality assurance manual for the Office of Waste Isolation.** (Union Carbide Corp., Oak Ridge, TN (USA). Office of Waste Isolation). 26 Sep 1977. Contract W-7405-ENG-26. 52p. Dep. NTIS, PC A04/MF A01.

The manual provides guidelines for assuring safe and reliable siting, design, procurement and construction, operation, and decommissioning of a radioactive waste repository. The organization of the program is given and the program itself is defined. The program includes the site evaluation, site selection, design, procurement, fabrication, installation, and testing of any system or component that is safety related. It also included all necessary documentation and auditing. (JSR)

380 (Y/OWI/TM—36/1) **Technical support for GEIS: radioactive waste isolation in geologic formations. Volume I. Executive summary.** (Science Applications, Inc., Oak Ridge, TN (USA)). Apr 1978. Contract W-7405-ENG-26. 72p. Dep. NTIS, PC A04/MF A01.

This volume, Volume 1, "Executive Summary," is the first of a 23-volume series, "Technical Support for GEIS: Radioactive Waste Isolation in Geologic Formations," Y/OWI/TM-36, which supplements the "Contribution to Draft Generic Environmental Impact Statement on Commercial Waste Management: Radioactive Waste Isolation in Geologic Formations," Y/OWI/TM-44. The series provides a more complete technical basis for the preconceptual designs, resource requirements, and environmental source terms associated with isolating commercial LWR wastes in underground repositories in salt, granite, shale, and basalt. Wastes are considered from three fuel cycles; uranium and plutonium recycling, no recycling of spent fuel, and uranium-only recycling. This volume briefly describes the Alternate Repository Preconceptual Design Studies that led to the generic repository designs and the determination of the repository's resource requirements and environmental effluents.

381 (Y/OWI/TM—36/4) **Technical support for GEIS: radioactive waste isolation in geologic formations. Volume 4. Baseline rock properties: salt.** (Dames and Moore, White Plains, NY (USA)). Apr 1978. Contract W-7405-ENG-26. 159p. Dep. NTIS, PC A12/MF A01.

Salt has long been considered a possible repository medium for nuclear waste disposal. This report is a result of a literature survey to determine rock mass properties of a generic salt. The properties of bedded salt deposits from three different areas are considered, namely, the Salina basin, the Permia basin and the Paradox basin. Dome salts are also considered. Because of the special characteristics of salt, especially, its self-healing properties, the rock-mass properties are similar to the intact properties.

382 (Y/OWI/TM—36/8) **Technical support for GEIS: radioactive waste isolation in geologic formations. Volume 8. Repository preconceptual design studies: salt.** (Parsons, Brinckerhoff, Quade and Douglas, Inc., New York (USA)). Apr 1978. Contract W-7405-ENG-26. 182p. Dep. NTIS, PC A09/MF A01.

This volume, Volume 8 "Repository Preconceptual Design Studies: Salt," is one of a 23-volume series, "Technical Support for GEIS: Radioactive Waste Isolation in Geologic Formations," Y/OWI/TM-36, which supplements the "Contribution to Draft Generic Environmental Impact Statement on Commercial Waste Management: Radioactive Waste Isolation in Geologic Formations," Y/OWI/TM-44. The series provides a more complete technical basis for the preconceptual designs, resource requirements, and environmental source terms associated with isolating commercial LWR wastes in underground repositories in salt, granite, shale and basalt. Wastes are considered from three fuel cycles: uranium and plutonium recycling, no recycling of spent fuel and uranium-only recycling. This document describes a preconceptual design for a nuclear waste storage facility in salt. The facility design consists of several chambers excavated deep within a geologic formation together with access shafts and supportive surface structures. The facility design provides for: receiving and unloading waste containers; lowering them down shafts to the mine level; transporting them to the proper storage area, and emplacing them in mined storage rooms. Drawings of the facility design are contained in TM-36/9, "Drawings for Repository Preconceptual Design Studies: Salt."

383 (Y/OWI/TM—36/14) **Technical support for GEIS: radioactive waste isolation in geologic formations. Volume 14. Repository preconceptual design studies: basalt.** (Parsons, Brinckerhoff, Quade and Douglas, Inc., New York (USA)). Apr 1978. Contract W-7405-ENG-26. 141p. Dep. NTIS, PC A07/MF A01.

This document describes a preconceptual design for a nuclear waste storage facility in basalt. The facility design consists of several chambers excavated deep within a geologic formation together with access shafts and supportive surface structures. The facility design provides for: receiving and unloading waste containers; lowering them down shafts to the mine level; transporting them to the proper storage area and emplacing them in mined storage rooms. Drawings of the facility design are contained in TM-36/15, "Drawings for Repository Preconceptual Design Studies: Basalt."

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 329, 339, 370, 380, 382, 1346, 1347, 1348, 1349, 1421

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 329, 374, 1309, 1310, 1311, 1343, 1344, 1345, 1350, 1351, 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1359, 1371, 1497, 1511, 1513, 1575

384 (UNI—1106) **Calculated 50-year dose to maximum individual from discharge to river of all radionuclides contained in 1301-N facility.** Diediker, L.P. (United Nuclear Industries, Inc., Richland, WA (USA)). 23 Jun 1978. Contract EY-76-C-06-1857. 2p. Dep. NTIS, PC A02/MF A01.

Calculations have been made of the radionuclide inventory of the 1301-N facility by the year 1990, using sampling records through 1976 and extrapolating to 1990. It has been assumed that no modifications would be made to N Area facilities to reduce radioactive discharges to the crib. The offsite doses reported are based on the assumption that the entire radionuclide content of the 1301-N crib and trench are released to the river. All calculations of the radiologi-

cal impact resulting from the hypothetical discharge were made using the most conservative assumptions available in each case. The dose to a maximally exposed offsite individual was calculated assuming the discharge of the entire 1301-N facility 1990 inventory during a one-week period of minimum river flow. Dose calculations were performed using the current PNL computer model for the one-year intake of each radionuclide and 50 year exposure to the maximum individual. The following table gives the calculated dose to the whole body and other critical organs of the hypothetically exposed individual.

385 Criticality accidents at facilities for processing fissile material. Characteristics, detection and action procedures. Barbry, F.; BOUSQUET, J. (CEA CENTRE D'ETUDES NUCLEAIRES DE SACLAY, 91 - GIF-SUR-YVETTE (FRANCE)); PRIGENT, R.; RENARD, C. (CEA CENTRE D'ETUDES NUCLEAIRES DE FONTENAY-AUX-ROSES, 92 (FRANCE)). pp 473-482 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977). (In French)

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

In spite of the precautions which are always taken to avoid a criticality accident at facilities where fissionable material is handled or stored, the risk of such an accident occurring is not ruled out. It is difficult to conceive of a system which would afford sufficient biological protection to all the sensitive parts of the facility. In the event of an accident, it is therefore essential to alert the operators as early as possible, since their immediate and rapid withdrawal is the only way of limiting exposure. The CRAC (Radiological Consequences of a Criticality Accident) experiments carried out on fissionable solutions and their interpretation afford the best means of characterizing this type of accident. New detection criteria have been defined and new probes developed which are sensitive both to neutrons and gammas and have a dose response over a wide range of accident dynamics. Any false alarm which could affect the safety of facilities should be avoided. For this reason the detection network for criticality accidents was designed so that it would offer a sufficient degree of reliability. The paper includes a discussion of the rules to be followed when the network is set up. If the dose rate of each probe is known at all times it is possible to find the approximate location of the accident, to follow its pattern and to provide for the action to be taken. Where human action is not possible, use can be made of remote-controlled devices of the Virgule type; the characteristics of this equipment are mentioned.

386 Swiss emergency organization for nuclear and chemical accidents. Brunner, H. (EIDGENOESSISCHES INST. FUER REAKTORFORSCHUNG, WUERENLINGEN (SWITZERLAND)); WINIGER, P. (EIDGENOESSISCHE KOMMISSION ZUR UEBERWACHUNG DER RADIOAKTIVITAET, BERN (SWITZERLAND)). pp 291-300 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977).

History, basic concepts, organization and means of the Swiss Emergency Organization are described and some specific problems and solutions are discussed. Preference is assigned to organizations, structures and means already in existence. The frame for coordination of the efforts is given by the principal arrangements of the total defense. The most important installation is a permanent Monitoring Center operating 24 hours a day attached to the national weather service. The concept of the emergency organization is based on an analysis of the possible types of events, the sequences of phases of an accident, the dominant character of an incident, the protection objectives and the possible or available preventive and protective measures. The systematic analysis of these factors shows clearly in which cases the federal emergency organization has to operate and which events can be handled with the normal means of the civil authorities. Special topics such as the concept of dose limits, vertical evacuation to civil defense shelters or cellars and the project for an automatic nation-wide meteorological and radiological monitoring network are presented.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 356, 1279, 2127

387 (LA—7211-PR) Nuclear Safeguards Research and Development program status report. Progress report, September—December 1977. Sapir, J.L. (comp.). (Los Alamos Scientific Lab., NM (USA)). Mar 1978. Contract W-7405-ENG-36. 95p. Dep. NTIS, PC A05/MF A01.

This report presents the status of the Nuclear Safeguards Research and Development program pursued by LASL Safeguards Groups Q-1, Q-2, Q-3, and Q-4. Topics covered include nondestructive assay technology development and applications, international safeguards, perimeter safeguards and surveillance, concepts and subsystems development (e.g., DYMAC program), integrated safeguards systems, training courses, and technology transfer.

388 (LA-UR—78-1147) Safeguards implementation in the nuclear fuel cycle. Keepin, G.R. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 29p. (CONF-780904—1). Dep. NTIS, MF A01.

From 2. Pacific Basin conference; Tokyo, Japan (24 Sep 1978).

Portions of document are illegible.

Today's trend toward tightening regulations and increasingly stringent safeguards underscores the necessity for safeguards criteria to be incorporated at an early stage in the design of future fuel cycle facilities. IAEA and national safeguards systems are discussed. The U.S. Safeguards R and D program is described in some detail: reference facility (Barnwell) safeguards system design, dynamic materials accounting systems (DYMAC), etc. The safeguards problem of the conversion process (Pu nitrate to PuO_2) is considered. Recent developments and trends in measurement technology are reviewed. 79 references, 6 figures. (DLC)

389 (NUREG—0450(Vol.1)) Report of the Material Control and Material Accounting Task Force: summary. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards). Mar 1978. 37p. NTIS $4.50.

A special review was made of the safeguards maintained by licensees possessing 5 kg or more of strategic special nuclear material (SSNM), i.e., plutonium, uranium-233, or uranium enriched in the uranium-235 isotope to 20 percent or more. A Task Force was formed to define the roles and objectives of material control and material accounting in the NRC safeguards program; recommend goals for material control and material accounting systems based on their roles and objectives; assess the extent to which the existing regulatory base meets or provides the capability to meet the recommended goals; and to provide direction for material control and material accounting development, including both near-term and long-term upgrades. Based on results of Task Force investigations it is recommended that licensee plans for measurement control programs be submitted in response to Section 70.57(c) of Title 10 of the Code of Federal Regulations. Other recommendations include the review and upgrading, as necessary, of measurement error propagation models used by each licensee; revision of Nuclear Materials Management and Safeguards System (NMMSS) reporting entities for SSNM licensees to be consistent with the partitioning of facilities into plants or, if appropriate, accounting units; review of NMMSS reporting entities for SSNM licensees to assure that data for high enriched uranium operations are clearly separated from low enriched uranium operations; upgrading of the editing by NMMSS of reported licensee safeguards data for accuracy and consistency; and the acquisition of (a) a secure interactive computer capability for use in collecting, storing, sorting, and analyzing special nuclear material accounting data, and (b) associated flexible computer software that presents safeguards information in a succinct and comprehensive manner.

390 (NUREG—0450(Vol.2)) Report of the Material Control and Material Accounting Task Force: the role of material control and material accounting in the safeguards program. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards). Mar 1978. 161p. NTIS $8.00.

Results are presented of NRC Task Force investigations to identify the functions of a safeguards program in relation to the NRC safeguards objective, define the role and objectives of material control and material accounting systems within that program, develop goals for material control and material accounting based on those roles and objectives, assess current material control and material accounting requirements and performance levels in the light of the goals, and recommend future actions needed to attain the proposed goals. It was found that the major contribution of material accounting to the safeguards program is in support of the assurance function. It also can make secondary contributions to the prevention and response functions. In the important area of loss detection, a response measure, it is felt that limitations inherent in material accounting for some fuel cycle operations limit its ability to operate as a primary detection system to detect a five formula kilogram loss with high assurance (defined by the Task Force as a probability of detection of 90 percent or more) and that, in those cases, material accounting can act only in a backup role. Physical security and material control must make the primary contributions to the prevention and detection of theft, so that safeguards do not rely primarily for detection capabilities on material accounting. There are several areas of accounting that require more emphasis than is offered by the current regulatory base. These areas include: timely shipper-receiver difference analysis and reconciliation; a demand physical inventory capability; improved loss localization;discard measurement verification; timely recovery of scrap; improved measurement and record systems; and limits on cumulative inventory differences and shipper-

receiver differences. An increased NRC capability for monitoring and analyzing licensee accounting data and more timely and detailed submittals of data to NRC by licensees are recommended.

391 (NUREG—0450(Vol.3)) **Report of the Material Control and Material Accounting Task Force: blueprint for the future.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards). Mar 1978. 147p. NTIS $8.00.

A blueprint is presented for the development of improved material control and material accounting systems by integrating the goals and capabilities of material control and material accounting and recommending specific upgrading actions. An analysis is included of several specific issues and developing recommendations for future actions related to those issues. It is felt that there is a need for a program to define specific quantified goals for an integrated safeguards program, and to monitor safeguards programs in terms of these goals. NRC should give highest priority to developing regulations and guides that will enable material control to make a greater contribution to safeguards by providing greater timeliness and sensitivity in detecting and assessing material losses. It is recommended that a technical study be conducted to determine a quantitative measure or at least a figure of merit for the effectiveness of a security clearance program, based upon full field background investigations, in protecting against malevolent conspiracies involving two or more security cleared individuals. It is also recommended that a specific effort be initiated to formulate an approach to combating collusion. This effort should specifically consider the contribution that material control and material accounting programs can make to safeguards effectiveness in this area.

392 (NUREG—0450(Vol.4)) **Report of the Material Control and Material Accounting Task Force: appendices.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Material Safety and Safeguards). Mar 1978. 139p. NTIS $7.25.

Five appendixes are presented. The first comprises a chronological development of material control and material accounting requirements. The second gives a description of current NRC control and material accounting requirements, practices, and capabilities. In the third a description is given of NRC's research and technical assistance program concerning the measurement and measurement quality control elements of licensee material control and material accounting systems. The fourth covers some special considerations related to inventory differences and their analysis. In the fifth a detailed description is presented of the evaluation methodologies used in development of improved material control and material accounting systems. (JRD)

393 (NUREG/CR—0019) **Value impact of vault automation in special nuclear material storage.** McDuffee, W.T.; Hamel, W.R. (Oak Ridge National Lab., TN (USA)). 26 Apr 1978. Contract W-7405-ENG-26. 61p. (ORNL/NUREG—33). Dep. NTIS, PC A04/MF A01.

Cost/benefit studies in this report indicate that automation of storage systems is the most favorable approach to gaining safeguards benefits in special nuclear material (SNM) storage vaults. The studies are based on the SNM storage vault of a conceptual 200-metric tons (MT)/year mixed-oxide fuel fabrication facility. Two alternative nonautomated vault concepts are developed and evaluated for safeguards benefits. One emphasizes the use of additional security/surveillance personnel in SNM storage vault operation; the other emphasizes structural and procedural barriers to achieve isolation of SNM from operating personnel. The costs of each alternative are estimated and the cost/benefits compared with those of the conceptual fully automated vault developed in the earlier desirability and feasibility study.

394 (NUREG/CR—0101) **Tactical game for use in the development and evaulation of road-transit physical protection systems.** Keeton, S.C.; Gallagher, R.J. (Sandia Labs., Albuquerque, NM (USA)). May 1978. Contract EY-76-C-04-0789. 13p. (SAND—78-8652). Dep. NTIS, PC A02/MF A01.

In order to gain insight into the various parts of the transportation physical protection system, a tactical board game, AMBUSH, was developed. The paper discusses the purpose and features of AMBUSH. AMBUSH can be used to help provide insight into the value of additional vehicles, guards, cargo barriers, equipment and alternative tactics. One value of using AMBUSH comes from the player participation in the events that take place. The tasks that are executed at any game turn are based on a human interpretation of the current overall situation and on which strategies appear to optimize the chance of success. Thus, this game may also be valuable as a training device for the transportation guard force. An advantage over computer-based combat simulation models is that AMBUSH is easily transportable and relatively inexpensive.

FUSION FUELS

WASTE MANAGEMENT

395 (BNL—24566) **Effects of waste management on the impact of fusion power.** Botts, T.; Powell, J. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 7p. (CONF-780508—58). Dep. NTIS, PC A02/MF A01.

From 3. meeting on the technology of controlled thermonuclear fusion; Santa Fe, NM, USA (9 May 1978).

Throughputs and inventories of radioactive materials that would have to be managed by a country whose primary form of electrical generation is fusion are estimated. Whole body dose rates for the entire population due to normal and off-normal incidents are calculated. For the case of equilibrium systems, two fusion cases are compared to an advanced fission power case. Comparisons are made for various stages of the fuel cycle and activated materials cycles. Fission reactor radiological impact is dominated by fuel reprocessing facility releases. These releases will decrease significantly if methods of containing ^{85}Kr are implemented. Tritium releases during normal plant operations comprise most of the radiologic impact for both fusion cases. Total dose rates are estimated to be roughly two orders of magnitude lower for fusion than for fission reactors.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

396 (MLM—2506) **Mound Facility activities in chemical and physical research: July—December 1977.** (Mound Lab., Miamisburg, OH (USA)). 1 May 1978. Contract EY-76-C-04-0053. 57p. Dep. NTIS, PC A04/MF A01.

Isotope separation of Ar, C, ^{3}He, Kr, Ne, O, and Xe isotopes is reported. TiFeH/sub x/, TiCoH/sub x/, TiCuH/sub x/, and VH/sub x/ were studied using NMR (proton relaxation times). VD/sub x/ and VT/sub x/ were synthesized. The problem of calculating the valence state of Pu is discussed. A series solution to the plutonium (N,H) characteristic equation is suggested. Shipments of ^{231}Pa, ^{230}Th, and ^{229}Th are reported. Separation and processing of ^{234}U are also reported. Theoretical methods were developed to calculate temperature distributions as functions of water flow rate in liquid thermal diffusion columns. Diffusion coefficients were measured from 300 to 1200°K for Kr-Xe and Kr-Ar. New thermal diffusion factors are submitted for Ne-Ar.

HEAVY WATER PRODUCTION

397 (UCID—17736-78-2) **Development of advanced concepts for improved heavy water production technology.** Aldridge, F.T.; Herman, I.P.; Marling, J.B.; Wood, L.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1978. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

Three significantly different advanced heavy water production processes continued under active investigation. The process based on infrared multiple-photon dissociation satisfies the very high isotopic selectivity requirement for viable photochemical deuterium separation, based on observed single-step deuterium enrichment factors up to 1400-fold in dissociation of Freon-123. Preliminary experiments have commenced evaluation of reaction rates in the process based on vibrationally-enhanced deuterium halide addition into unsaturated hydrocarbons, as well as similar attractive bimolecular reactions. For the process based on intermetallic hydride chromatography, the new compound $CaNi_4Cu$ has been found to be preferable over $CaNi_5$, as it maintains a reproducible and acceptably high deuterium separation factor after more than ten hydriding and dehydriding cycles.

RADIATION SOURCES

398 (PNL—2572) **List of ERDA radioisotope customers with summary of radioisotope shipments FY 1977 (plus the transition quarter).** Simmons, J.L. (comp.). (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1978. Contract EY-76-C-06-1830. 47p. Dep. NTIS, PC A03/MF A01.

The thirteenth edition of the radioisotope customer list gives ERDA's (now DOE) FY-1977 and transition quarter radioisotope production and distribution activities by its facilities at Argonne National Laboratory; Pacific Northwest Laboratory; Brookhaven

National Laboratory; Hanford Engineering Development Laboratory; Idaho Operations Office; Los Alamos Scientific Laboratory; Mound Laboratory; Oak Ridge National Laboratory; Savannah River Laboratory; and United Nuclear Industries, Inc. The information is divided into four sections. Sect. I is an alphabetical list of domestic and foreign customers and their addresses. Sect. II is an alphabetical list of isotopes that are cross-referenced to customer numbers and divided into the domestic and foreign categories. Sect. III is an alphabetical list of states and countries, and is also cross-referenced to customer numbers, indicating geographical concentrations of isotope users. Sect. IV summarizes the FY-1977 radioisotope shipment activities of laboratories in a comprehensive table providing an alphabetical listing of the isotopes and their suppliers. The shipments, quantities, and dollars are broken down for each isotope under the domestic, foreign, and project (ERDA facilities) categories, and the total figures for each isotope are also provided.

ISOTOPIC POWER SUPPLIES

399 (LA—7314-MS) **Safety test of an improved multihundred watt FSA: launch abort, solid propellant fire.** Seabourn, C.M. (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 22p. Dep. NTIS, PC A02/MF A01.

This safety test consisted of exposing a simulant-fueled Improved Multihundred Watt Fuel Sphere Assembly, containing a Pt-3008 sphere holding the fuel simulant, to a single proximity fire of UTP-3001 solid rocket propellant for 10.5 min. The graphite outside shell sustained only minor abrasion damage. It was covered on one side with a heavy deposit of alumina from the fire mixed with silica from the test bed. The Pt-3008 shell had small amounts of carbon, alumina, and silica deposited on its surface but sustained no other damage. The PT-3008 sphere was not breached, and therefore the fuel sphere assembly would not release fuel in a solid-propellant fire of a launch abort. 12 figures.

DESIGN AND FABRICATION

400 (LA—7416-PR) **General-Purpose Heat Source Project, Space Nuclear Safety Program, and Radioisotopic Terrestrial Safety Program. Progress report, June 1978.** Baker, R.D. (comp.). (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 39p. Dep. NTIS, PC A03/MF A01.

Studies related to the use of $^{238}PuO_2$ in radioisotopic power systems carried out for the Advanced Systems and Materials Production Division by the Los Alamos Scientific Laboratory are described. The three programs involved are: (1) General-Purpose Heat Source Development; (2) Space Nuclear Safety; and(3) Radioisotopic Terrestrial Safety.

HYDROGEN

PRODUCTION

REFER ALSO TO CITATION(S) 511

ELECTROLYSIS

REFER ALSO TO CITATION(S) 440

401 (CONF-780571—3) **Economic criteria for the improvement of electrolyzer technology.** Gregory, D.P.; Blurton, K.F.; Biederman, N.P. (Institute of Gas Technology, Chicago, IL (USA)). 1978. 10p. Institute of Gas Technology, Chicago, IL.

From 153. meeting of the Electrochemical Society; Seattle, WA, USA (21 May 1978).

The economics of present-day electrolyzers using off-peak power are examined for the production of commodity hydrogen. The sensitivity of capital cost and efficiency are compared. Some guidelines are given for the direction of future electrolyzer research and development.

COAL GASIFICATION

REFER ALSO TO CITATION(S) 109

STEAM-IRON PROCESS

REFER ALSO TO CITATION(S) 28, 29

STORAGE

REFER ALSO TO CITATION(S) 976

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 401

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 976

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 440, 1530

PREPARATION

REFER ALSO TO CITATION(S) 1230

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 25, 260

402 (ORNL/Sub—7186/7) **Coal liquefaction process research, Mobil M-Gasoline process. R and D interim report No. 1.** (Parsons (Ralph M.) Co., Pasadena, CA (USA)). Jun 1978. Contract W-7405-ENG-26. 75p. Dep. NTIS, PC A04/MF A01.

This report summarizes the projected economic potential for the methanol-to-gasoline (M-Gasoline) process under development by Mobil Research and Development Corporation. The potential was reviewed by developing a preliminary economic estimation of the design, construction, and operation of a commercial-sized facility to produce 50,000 barrels per day (BPD) of gasoline. The review included a preliminary definition of facilities and projected economics for the production of methanol utilizing synthesis gas produced by the gasification of coal. The limited time and effort allotted for completion of the study permitted moderate, but not exhaustive, optimization of the conceptual industrial complex. A summary of more recent data was received following completion of the study. Preliminary analysis of this more recent information indicated that it would not significantly alter the preliminary economic conclusions. At the direction of the Department of Energy, therefore, the conceptual design and economic evaluations were not revised to incorporate this later information. The primary objective of the study was to project the economic potential of the process. A secondary objective was to develop recommendations for improvements. Preliminary engineering was performed as required to define the basis for plant design and economic estimates.

403 **Biomethanation: anaerobic fermentation of CO_2/H_2 and CO to methane.** Augenstein, D.C.; Wise, D.L.; Cooney, C.L. pp vp of Sixty-ninth AIChE annual meeting. New York; American Inst. of Chemical Engineers (1976).

From 69. AIChE annual meeting; Chicago, IL, USA (28 Nov 1976).

Anaerobic fermentation of CO_2/H_2 and CO to methane was carried out under an ERDA contract with a culture from a sewage-sludge digester effluent. The results indicate that the process could be used to convert coal-gasifier product gases to methane. In a 1l continuous culture anaerobic fermenter operating at up to 450 psig and 370°C, carbon dioxide and hydrogen were converted to 15 to 30 l of methane per liter of liquid reactor contents per day (VVD) for extended periods of time. With microorganism recycle and continuous culture at high dilution rates, 1 atm, and 37°C in a 3 l fermenter, methane was continuously produced at 100 VVD. The use of a carbon-14 labeled carbon dioxide showed that 97.6 percent of the feed carbon dioxide consumed was converted to methane, with by-product diversion to biomass 1.8 percent and to organic acids 0.6 percent. Limited experiments with carbon monoxide confirmed its usability but at much lower rates (1 to 10 moles/l/hr).

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 431, 1474

404 (CONF-7710163—1) **Conversion of forest residues to a methane-rich gas.** Liu, K.T.; Feldmann, H.F. (Battelle Columbus Labs., OH (USA)). 1977. 18p. Dep. NTIS, PC A02/MF A01.
From Contractors meeting; Ballston Spa, NY, USA (25 Oct 1977).

Tables, charts, and graphs illustrating a talk on the catalytic conversion of forest residues to a methane-rich gas are compiled. (JSR)

405 **Kinetic model for pyrolysis of Douglas fir bark.** Tran, D.Q.; Rai, C. (Univ of Wyo, Laramie). *Fuel;* **57**: No. 5, 293-298(May 1978).

A kinetic study of catalysed and non-catalysed pyrolysis of Douglas fir bark was conducted using a DuPont 951 Thermogravimetric Analyzer. A kinetic model in which activation energy is assumed to be a linear function of the extent of reaction was used to describe the pyrolysis of bark. The order of reaction was found to be one for the non-catalysed and two for the catalysed bark. The model shows good agreement with the data reported by other investigators using a fluidized bed. 27 refs.

406 **Gasification of coal and refuse in a vertical shaft furnace.** Gold, L. US Patent 4,078,914. 14 Mar 1978. Filed date 31 Jul 1975. 6p.

The combustion of refuse, including all types of trash and garbage, in the presence of coal and/or coke and a fluxing agent in a vertical shaft furnace provides for the clean combustion of the refuse, the recovery of metallic wastes and the enhanced production of a gaseous fuel. By blending the refuse with the coal and/or coke and fluxing agent in a coal reaction, a fairly even distribution of the refuse will be achieved to prevent the compaction of the refuse and clogging of the furnace and to provide a more uniform controllable combustion temperature within the furnace thereby prolonging the life of the furnace lining. By using a conventional blast furnace, iron ore and/or scrap metal can also be added to the feed stock for the production of pig iron and the steam generated as a result of the high moisture content of the refuse can be utilized to react with the nascent pig iron within the furnace for the production of hydrogen to enrich the blast furnace gas to provide a high quality fuel gas. The refuse can be added directly to the furnace or be subjected to a preheating operation to reduce the moisture content and volume of the refuse. The steam generated in the pretreatment can be directed into the furnace to cause an enrichment of the furnace effluent gas or be utilized directly for heating or power generation.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 977

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 31

407 (FE—1759-6) **Conceptual design of a coal to methanol commercial plant: capital cost validation.** (Army Engineer Div., Huntsville, AL (USA)). 10 Feb 1978. Contract EX-76-C-01-1759. 29p. Dep. NTIS, PC A03/MF A01.

The US Army Engineer Division, Huntsville (USAEDH) has reviewed, validated, and updated a capital cost estimate of the Conceptual Design/Coal to Methanol Commercial Plant, prepared by Badger Plants, Inc. This facility was designed to have a feed rate of 74,000 tons per day of coal and 7,500 tons per day of limestone. The facility was designed to produce approximately 386,400 barrels per day of 96.5 weight percent methyl fuel, 28,600 barrels per day of chemical grade methanol, and 660 tons per day of sulfur. At full production, the plant will use approximately 330,000 kWh per hour and $11.4 million (1977 dollars) per year of catalysts and chemicals. At full capacity, the plant will employ approximately 1,715 people. Results of the USAEDH estimate showed a fixed capital cost of $3,489,179,900 which is greater than Badgers estimate of $3,105,103,800 (both estimates based on late 1977 dollars). The overall confidence factor was determined to be plus or minus 12.4 percent.

408 **Influence of nitrogen-containing compounds on the process of methanol synthesis.** Lender, A.A.; Krasnyanskaya, A.G. *Sov. Chem. Ind. (Engl. Transl.);* **10**: No. 3, 192-193(Mar 1978).
Translated from Khim. Prom.; No. 3, 177-178(1978).

The influence of N-methylpyrrolidone, dimethylformamide and ammonia on the yield from a copper-containing catalyst and on the quality of the crude methanol was studied when the synthesis was carried out at a pressure of 50 kg/cm^2 at 260 to 280°C. It was established that these compounds do not affect the yield of the catalyst, but significantly impair the quality of the crude methanol. The most undesirable admixture is dimethylformamide.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 431

PREPARATION

REFER ALSO TO CITATION(S) 109

409 **Stabilization of temperature conditions for a four-bed ammonia synthesis reactor.** Gavrilenko, M.I.; Kirillov, V.A. *Sov. Chem. Ind. (Engl. Transl.);* **10**: No. 4, 310-314(Apr 1978).
Translated from Khim. Prom.; No. 4, 283-286(1978).

Mathematical modeling was used to develop and study an automated control system (ASU) for the temperature conditions of a high-yield ammonia synthesis reactor. The dynamic characteristics of the catalyst granule and catalyst bed were studied. Control channels were selected. It is shown that reference calculations for adjusting ASU's can be done when the dynamics of the catalyst beds are described by a quasihomogeneous model with subsequent refinement using a model which takes into account external heat exchange between the granule surface and gas flow and lengthwise heat transfer through the catalyst shell.

410 **High activity copper-containing catalyst for low-temperature carbon monoxide conversion.** Anokhina, A.S.; Cherkasov, G.P.; Semenova, T.A.; Markina, M.I.; Boevakaya, E.A.; Yushkina, N.I.; Lyudkovskaya, B.G.; Shutov, Yu.M. *Sov. Chem. Ind. (Engl. Transl.);* **10**: No. 4, 315-316(Apr 1978).
Translated from Khim. Prom.; No. 4, 286-288(1978).

A copper-zinc-aluminum system may be used to produce a highly active and stable catalyst, the NTK-8, for the low-temperature conversion carbon monoxide by using the method of oxylate precipitation with subsequent calcination at 350 to 550°C. The catalyst has a lower bulk density and lower level of expensive copper compared to the industrial NTK-4 catalyst.

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 406, 545, 565, 943

411 **Combustion mechanisms in wood fired boilers.** Tuttle, K.L. (Weyerhaeuser Co., Tacoma); Junge, D.C. *J. Air Pollut. Control Assoc.;* **28**: No. 7, 677-680(Jul 1978).

The emissions from combustion of wood residue fuel in an experimental spreader-stoker boiler were measured at the Fairplay Test Facility at Oregon State University. Stack gases were monitored to determine levels of excess air, opacity, and particulate loading. Particulate emissions were measured to determine the effects of underfire air flow rate and fuel bed depth on particulate carry over rate. An experiment conducted at four energy release rates and two fuel bed depths indicated that increased bed depth has the effect of reducing particulate emissions and that the effect increases as energy release rate increases. The experiment also showed increased energy release rate has the effect of increasing particulate emissions. The effects were found to be statistically significant.

LIQUID WASTE FUELS

REFER ALSO TO CITATION(S) 943

GASEOUS WASTE FUELS

REFER ALSO TO CITATION(S) 943

HYDRO ENERGY

RESOURCES AND AVAILABILITY

412 (ORO—5560-1) **Solar electricity: Osmo—Hydro Power from aqueous saline solutions assessment of its potential. Final report No. 280378.** (InterTechnology/Solar Corp., Warrenton, VA (USA)).

28 Mar 1978. Contract EG-77-C-05-5560. 179p. Dep. NTIS, PC A09/MF A01.

The objective of this study was to determine the potential of Osmo-Hydro Power/sup TM/ (OHP) systems, to generate electricity in a practical and economic manner from aqueous saline solutions. The basic principle of OHP systems is to generate a pressurized liquid flow from water which permeates by pressure-retarded osmosis through a semipermeable membrane into a more concentrated salt solution and to discharge this pressurized flow through a hydraulic turbine. In effect, the free energy of mixing of the water and the salt solution is converted into mechanical energy. Calculations of performance and cost were made with a comprehensive model for OHP systems using estimated properties and estimated current costs for an experimental glass hollow fiber membrane and a du Pont-type aromatic polyamide fiber. A sensitivity analysis showed that an increase in the membrane water permeation coefficient has the most significant beneficial effect on electricity cost. Suitable locations for water-salt OHP systems depend upon the simultaneous availability of suitable water, a salt dome which can be solution mined or concentrated brine which can be solar evaporated, and net evaporation and suitable land for an evaporation pond. A once-through system must be located near the ocean for disposal of the waste brine. The use of brackish water (approximately 1,000 ppM) as the "fresh" water has only a small effect on system performance. Locations in the Southwest show the most potential for water-salt OHP systems with an evaporation pond. However, to increase the potential for implementation of water-salt OHP systems, it will be necessary to develop membranes capable of utilizing brackish water or even seawater on the bore side.

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 877

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 1574, 1575

SOLAR ENERGY

413 **Principles and applications of solar energy.** Cheremisinoff, P.N.; Regino, T.C. Ann Arbor, MI; Ann Arbor Science Publishers, Inc. (1978). 255p.

The following chapters are included: solar energy—historical; solar energy availability; thermal collection devices; thermal solar energy applications; photovoltaic generation of electricity; energy from the wind; ocean thermal gradient power; chemical conversion of solar energy; and biological conversion of solar energy. Insolation data tables and maps are included in the appendix. (MHR)

RESOURCES AND AVAILABILITY

414 (SOLAR/0006—78/20) **Test report on the National Solar Data System Accuracy Test using the MOD 1 SDAS.** (International Business Machines Corp., Huntsville, AL (USA)). 24 May 1978. Contract EG-77-C-01-4049. 50p. Dep. NTIS, PC A03/MF A01.

The basic objective of the National Solar Data System Accuracy Test was to determine the end-to-end accuracy of the Data System, identify sources of data errors and determine their contribution to any data collection inaccuracies. The results include the tests using the Mod 1 Site Data Acquisition System (SDAS). The test program was divided into three phases: sensors were individually calibrated, static temperature tests were performed to verify the data path, and dynamic tests were performed to determine the accuracy of system level data collection and processing. A general description of the Data System is given, the test methods are described and the test results are presented. Additionally, the results of a pyranometer verification test by the National Oceanic and Atmospheric Administration is presented.

415 (TID—28581) **Study of feasibility of utilizing solar, wind and geothermal energy in Hobbs, New Mexico.** (Oklahoma Univ., Norman (USA). Center for Economic and Management Research). 2 Aug 1977. Contract EY-76-S-05-5231. 183p. Dep. NTIS, PC A09/MF A01.

It is indicated that of the three types of renewable energy sources considered: (1) geothermal energy is not available conveniently to the Hobbs area and is not considered in depth; (2) wind energy, based on twenty-four hour averages of wind speed and density, is not a viable supplementary source but, when considering winds during the hours between 9:00 a.m. and 5:00 p.m., is economically feasible; and (3) solar energy contains more than six times the energy per square meter that wind does and therefore is more attractive economically and should be pursued. Geographic characteristics pertinent to the southeastern portion of New Mexico are studied with emphasis on Lea County. The area demand for energy is discussed. The evaluation of geothermal energy sources, the wind, and solar energy as usable energy sources is discussed. The three most common types of solar energy systems are discussed. A number of specific solar energy systems are described. The systems are evaluated on the basis of available cost projections. The results are summarized and recommendations are presented. (MHR)

ECONOMICS

REFER ALSO TO CITATION(S) 422, 436, 456

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 443, 459, 1575

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 465, 467, 479

416 (CONF-780619—16) **Cuprous oxide photovoltaic cells.** Trivich, D.; Wang, E.Y.; Komp, R.J.; Kakar, A.S. (Wayne State Univ., Detroit, MI (USA)). 1978. Contract ET-78-S-02-4726. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE photovoltaic specialists conference; Washington, DC, USA (5 Jun 1978).

Cuprous oxide, with a band gap of 2.0 eV, is an attractive material for solar cells because of low cost and great availability. The current conversion efficiency is 1%, but theoretical estimates are >13%. For various Schottky barriers, e.g., Al/Cu_2O, it is proposed that the V/sub oc/ is limited by chemical conversion of the junctions to Cu/Cu_2O junctions, and the model is supported by Auger and ESCA results. It is proposed to avoid the reaction by use of an oxide interlayer as in Al/Al_2O_3/Cu_2O, which also gives an MIS structure, but only minimal success has yet been achieved with the methods tried. Sb_2O_3 and SiO/sub x/ layers were explored. Another approach could be to use oxide heterojunctions on Cu_2O. Several were explored and ZnO/Cu_2O was best. In and Cd are effective dopants for Cu_2O. With samples annealed at 500°C, diffusion lengths of approximately 4 μm were measured by an SPV method. The spectral sensitivity of Cu/Cu_2O cells has a threshold at 630 nm and a maximum at 500 nm.

417 (COO—4094-6) **Visual defects in terrestrial photovoltaic modules.** Forman, S.E. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 21 Mar 1978. Contract EY-76-C-02-4094. 31p. Dep. NTIS, PC A03/MF A01.

During the past year, over 4,650 photovoltaic modules from various manufacturers were received. In order to establish a data base against which to measure degradation, each module was subjected to a thorough visual inspection using microscopes at powers up to 30X. A multitude of defects were found that included cracked cells, soldering anomalies, encapsulant delamination, entrapped debris, uncured encapsulant and interconnects protruding through the encapsulant. Specific defects which have the potential to cause premature electrical failure or degradation in the field are enumerated. In addition, some visual examination results for modules with six months' field service at MIT/Lincoln Laboratory's photovoltaic-powered agricultural experiment in Nebraska are presented. The excellent performance record of this system during its first six months of operation is noted.

418 (DOE/JPL/954343—11) **Process feasibility study in support of silicon material, Task I. Quarterly technical progress report (XI).** Fang, C.S.; Hansen, K.C.; Miller, J.W. Jr.; Yaws, C.L. (Lamar Univ., Beaumont, TX (USA). Dept. of Chemical Engineering). Jun 1978. Contract NAS-7-100-954343. 40p. Dep. NTIS, PC A03/MF A01.

Major activities focused on process system properties, chemical engineering and economic analyses during this reporting period. Analysis of process system properties was continued for silicon source materials. Primary efforts centered on data collection, analysis, estimation and correlation. Property data for silicon tetrachloride

are reported for critical constants (temperature, pressure, volume, compressibility factor); vapor pressure; heat of vaporization; gas heat capacity and liquid heat capacity. Silicon tetrachloride is the source material in several processes under consideration for solar cell grade silicon production. Final experimental values for gas phase thermal conductivity of the silicon source materials silane, dichlorosilane, trichlorosilane, tetrachlorosilane, and tetrafluorosilane are reported in the temperature range 25 to 350°C. These final values reflect a refinement of previously reported preliminary values after complete calibration of the temperature measuring apparatus. Chemical engineering analysis of the Union Carbide silane process (Case C-Revised Process) was continued with primary efforts being devoted to the preliminary process design. Status and progress are reported for base case conditions, process flow diagram, reaction chemistry and equipment design. Current engineering design is in progress for the several distillation columns which separate the liquid chlorosilanes and provide purified silane product.

419 (DOE/JPL/954589—5) **Development of a process for high capacity arc heater production of silicon for solar arrays. Low-cost solar array project, silicon materials task. Quarterly technical report, January—March 1978.** Reed, W.H. (Westinghouse Electric Corp., Trafford, PA (USA). Power Circuit Breaker Div.). 1978. Contract NAS-7-100-954589. 136p. Dep. NTIS, PC A07/MF A01.

A program has been established at Westinghouse to develop a high temperature silicon production process using existing electric arc heater technology. Silicon tetrachloride and a reductant will be injected into an arc heated mixture of hydrogen and argon. Under these high temperature conditions, a very rapid reaction is expected to occur and proceed essentially to completion, yielding silicon and gaseous sodium chloride. Techniques for high temperature separation and collection of the molten silicon will be developed using standard engineering approaches, and the salt vapor will later be electrolytically separated into its elemental constituents for recycle. Preliminary technical evaluations and economic projections indicate not only that this process appears to be feasible, but that it also has the advantages of rapid, high capacity production of good quality molten silicon at a nominal cost. The program consists of a four-phase effort directed to the development and implementation of this technology. The initial phase of the program, Phase I, was an eleven-month study funded by JPL which was completed in September, 1977. Phase I was defined as a comprehensive feasibility and engineering review of the reaction process, and a formulation of the design for a test system to experimentally verify the high temperature reaction. Phase II, currently underway, involves a multi-task approach including (1) a detailed engineering analysis of the entire process; (2) design, fabrication, and assembly of the experimental system; (3) experimental testing of the reduction reaction to produce silicon and (4) complementary research programs to augment the experimental system design. The Phase II effort was initiated in October, 1977, and work is described in detail on the various stages of this effort.

420 (DOE/NASA/1022—78/30) **Performance and stability analysis of a photovoltaic power system.** Merrill, W.C.; Blaha, R.J.; Pickrell, R.L. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Aug 1978. Contract EX-76-A-29-1022. 44p. (NASA-TM—78880). Dep. NTIS, PC A03/MF A01.

Recently much emphasis has been placed on the conversion of solar energy to more useable energy forms. One method is the direct conversion of solar insolation to a dc voltage and current by the use of solar cells. This dc power can then be "inverted" to ac power compatible with commercial utility lines to drive various ac loads. This report studies the performance and stability characteristics of one such system, a 10 kVA photovoltaic power system. The system is studied using linear Bode analysis and a nonlinear analog simulation. Power conversion efficiencies, system stability, and system transient performance results are given for system operation at various levels of solar insolation. Additionally, system operation and the modeling of system components for the purpose of computer simulation are described.

421 (SAND—78-0875) **Reliability concerns and life-test procedures for concentrator solar cells.** McLevige, W.V. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 13p. Dep. NTIS, PC A02/MF A01.

The factors of concern in concentrator solar cell reliability are outlined, and several types of life-test procedures are described. Some preliminary results of life testing on Si and AlGaAs/GaAs concentrator solar cells are discussed.

422 (SAND—78-0955C) **Status of the DOE photovoltaic systems engineering and analysis project.** Jones, G.J.; Schueler, D.G. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 6p. (CONF-780619—14). Dep. NTIS, PC A02/MF A01.

From IEEE photovoltaic specialists conference; Washington, DC, USA (5 Jun 1978).

The economic viability of photovoltaic power systems depends not only on the reduction of photovoltaic array prices but also on the realization of acceptable total installed system price. The allowable total installed system price is calculated for various major application sectors, based on a range of projected levelized energy costs. These allowable prices are then compared to projected prices which are obtained by examining the current and future expected prices of the major subsystems comprising an operational system. Based on this comparison an assessment of the status of the major subsystem technologies, exclusive of the photovoltaic array, is given and areas requiring emphasis are identified.

423 (SAND—78-1277C) **Optimization of terrestrial photovoltaic power systems.** Linn, J.K. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 5p. (CONF-780619—15). Dep. NTIS, MF A01.

From IEEE photovoltaic specialists conference; Washington, DC, USA (5 Jun 1978).

Portions of document are illegible.

Optimization of terrestrial photovoltaic (PV) power systems implies the identification and selection of system components which minimize the overall cost of power. The methodology, techniques, and some results are discussed for optimization of PV subsystem design tradeoffs. Included are (1) methods of orientation for flat plates and concentrating collectors, (2) collector type, (3) power conditioning sizing, (4) electrical energy storage sizing, and (5) operation temperatures. The optimal system type, component size(s) and resulting power costs are shown to be extremely dependent upon geographical location, PV cell costs, individual load characteristics, and component performance values.

424 (SAND—78-7025(Vol.1)) **System design report for a 10 kilowatt photovoltaic concentrator system. Volume I. Introduction; system design; design tradeoffs; system performance.** (Spectrolab, Inc., Sylmar, CA (USA)). May 1978. Contract EY-76-C-04-0789. 282p. Dep. NTIS, MF A01.

Portions of document are illegible.

The detailed design of a 10 kW photovoltaic concentrator system has been completed in conjunction with the development of a 250 watt (nominal) concentrator unit, one integral module of the 10 kW system. The system consists of 40 of these modules. Each module uses two stage optical concentration. The optics consist of a linear parabolic trough and compound elliptical secondary mirrors. A geometrical concentration of 25 is used. The system tracks in two axes. The modules are mounted on a carousel for azimuth tracking and are ganged in parallel for elevation tracking. The design utilizes passive cooling which provides nominal cell operating temperatures in the range of 70 to 80°C. Extrapolating prototype unit test results, the 130 m^2 system output will be 11.5 kW with an ambient air temperature of 18°C and a wind of 6 m/sec.

425 (SAND—78-7025(Vol.2)) **System design report for a 10 kilowatt photovoltaic concentrator system. Volume II. Appendices.** (Spectrolab, Inc., Sylmar, CA (USA)). May 1978. Contract EY-76-C-04-0789. 189p. Dep. NTIS, MF A01.

Portions of document are illegible.

Appendices for volume I, which presents the detailed design of a 10 kW photovoltaic concentrator system, are given. Topics include: (1) parabolic mirror skin thickness requirements for wind loading; (2) structural adhesives selection and evaluation; (3) drive system performance and tracking system power supply; (4) sun sensor and electronics packaging; (5) tracking logic and errors; (6) shading studies regarding structures; (7) estimate of moment of inertia of 10 kW array; (8) weight and center of gravity estimates of structural and mechanical components; (9) summaries of drive train loads and effects of wind loads on components; (10) engineering drawings of 250 watt concentrator module; (11) final performance tests of prototype 250 watt concentrator unit; (12) mapping of primary mirror optical configuration; (13) negative half-string performance tests under concentration using pulse simulator; and (14) electrical performance tests and inspection during cell string assembly and encapsulation. (WHK)

426 (SAND—78-7064) **Effects of encapsulation on the optical and thermal response of solar cells used in concentrated-flux systems. Final report.** Wood, V.E.; Kenan, R.P.; Gaines, G.B. (Battelle Columbus Labs., OH (USA)). 28 Apr 1978. Contract EY-76-C-04-0789. 63p. Dep. NTIS, PC A04/MF A01.

For photovoltaic arrays to become a practical means of solar-energy conversion on a large scale, it will be necessary for the arrays to operate with small degradation in electrical output and with a minimum of repair and maintenance for 20 years in order to recover the energy expended in manufacturing and deploying the arrays. To accomplish this, it will be necessary to protect the solar cells and the electrical leads in these arrays from deleterious environmental effects. One way to reduce directly these effects is to encapsulate each solar cell with a material (or a stack of materials) which allows the incident solar radiation to reach the cell, but which protects it from

the atmosphere. Encapsulating the cell, however, is bound to affect the amount of solar radiation absorbed within the semiconductor, and thus the cell's electrical output. The encapsulation is likely, as well, to affect the thermal balance of the system, and thus the steady-state operating temperature of the cell. These effects are particularly significant in concentrator systems, where a relatively large flux of solar energy is focused, by lenses or mirrors, onto a relatively small number of cells. These cells are likely to be constructed using a more advanced technology than that used in flat-plate systems, and it is important to assess quantitatively the changes that encapsulation will produce on the optical and thermal behaviors. Such an assessment is presented. The techniques for making such an assessment are described, and are applied to a specific system with several candidate encapsulants. The system chosen for representative calculations is of the Sandia type, involving molded plastic Fresnel-lens concentrators, low-resistivity n^+ - p silicon cells, Si_3N_4 antireflection coatings, and aluminum baseplates providing a common heat sink for each 27-cell array.

427 Solar panel with uv absorber. Lindmayer, J. US Patent 4,093,473. 6 Jun 1978. Filed date 15 Jun 1977. 4p.

A solar panel is described including photovoltaic cells encapsulated in a silicone resin containing an ultraviolet light absorber that will inhibit corrosion of metallic cell parts and resin delamination while having no substantial, adverse effect on curing of the resin.

428 Inexpensive solar cell and method therefor. King, W.J. US Patent 4,086,102. 25 Apr 1978. Filed date 13 Dec 1976. 16p.

Solar cells are manufactured by a simplified method in which a single protective layer acts as an anti-reflection coating and an encapsulation. In cases where the junction is formed by ion implantation techniques, the same layer also serves as the implantation oxide. In addition, this multi-purpose layer may also serve as a mass analyzer, allowing the desired species of ions to reach the surface of the semiconductor but blocking the heavier undesired species. The necessary contacts may be formed prior to implantation, and the use of alloyed aluminum contacts with aluminum oxide passivation permits a simplified contacting procedure. A fully automatic contacting method and configuration for linear materials is also disclosed.

429 Effects of impurity concentration on the properties of homojunction and heterojunction solar cells. Hsu, L. Detroit; Wayne State Univ. (1977). 123p. University Microfilms Order No. 78-05,189.

Thesis (Ph. D.).

Effects of impurity concentration on the properties of silicon homojunction and In_2O_3/Si, /Ge, /GaAs, /InP heterojunction solar cells have been investigated both experimentally and theoretically. For the homojunction, based on the continuity equation, it has been shown that both the built-in electric field gradient and the mobility gradient in the diffused region of a silicon solar cell act as effective recombination processes for the minority carrier. The short-circuit current contribution of n^+-diffused, of depletion, and of the base region for various impurity profiles and base resistivities were calculated. Impurity concentration in the diffused region was profiled by four-point probe differential Hall and resistivity measurement. The theoretical short-circuit current was compared with measured values as a function of wavelength and found to be in reasonably good agreement. In_2O_3/Si, In_2O_3/Ge, In_2O_3/GaAs and In_2O_3/InP heterojunction solar cells have been fabricated by a chemical vapor deposition method. All devices possess rectifying characteristics and photovoltaic properties. The experimentally observed polarities of the open circuit voltage and short circuit current are consistent with sample energy diagram of the heterojunction. Electron affinity value of In_2O_3 can also be determined from the results and the value is found to be in agreement with previously estimated values.

430 (NP-tr—1996) Prospect of high efficiency low cost SnO_2/Si solar cell. [nd]. Translation: source information not available. 2p. TIC.

Portions of document are illegible.

A transparent SnO_2 film is grown on a silicon wafer using a gaseous phase growth method. This method requires the substrate to be heated to a temperature of 300-400°C during growth, a temperature considerably lower than conventional techniques. Production cost should be low because the process can be easily automated. A test cell with an effective area of 3.9 cm^2 has been manufactured and yielded an efficiency of 9.5 percent. Twelve percent should be possible with current techniques. Electrode forming technology and a reduction in series resistance are being investigated as a means for increasing efficiency. Since the photoelectric conversion takes place near the surface of the device, this technique enables the use of a low price substrate, such as the multi-crystal substrate.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 404

431 (ALO—3729-1) Systems study of fuels from grains and grasses. Phase I. Final report. Benson, W.; Allen, A.; Athey, R.; McElroy, A.; Davis, M.; Bennett, M. (Midwest Research Inst., Kansas City, MO (USA)). 24 Feb 1978. Contract EY-76-C-04-3729. 270p. Dep. NTIS, PC A12/MF A01.

The program reported on herein consists of a first phase analysis of the potential for significant and economically viable contributions to U.S. energy needs from grasses and grains by the photosynthetic production of biomass. The study does not include other cultivated crops such as sugar cane, sugar beets, cotton, tobacco, vegetables, fruits, etc. The scope of the study encompasses grain crop residues, whole plant biomass from grain crops and nongrain crops on cropland, and whole plant biomass from grasses on pasture, rangeland, and federal range. The basic approach to the study involves first an assessment of current total biomass generation from the various grasses and grains on cropland, pasture, range, and federal range, and aggregating the production by combinations of crop residues and whole plant biomass; second, evaluation of possibilities for introduction of new crops and expanding production to marginal or presently idle land; third, development of proposed reasonable scenarios for actually harvesting biomass from selected combinations of crop residues, forages and hays, and new crops from land now in production, plus additional marginal or underutilized land brought into production; and finally, assessment on national and regional or local scales of the production that might be affected by reasonable scenarios. This latter effort includes analysis of tentative possibilities for reallocating priorities and needs with regard to production of grain for export or for livestock production. The overall program includes a case study analysis of production economics for a representative farm of about 1,000 acres (405 ha) located in Iowa.

432 Biological solar energy conversion and U.S. energy policy. Pimentel, D.; Nafus, D.; Vergara, W.; Papaj, D.; Jaconetta, L.; Wulfe, M.; Olsvig, L.; Frech, K.; Loye, M.; Mendoza, E. (Cornell Univ., Ithaca, NY). *Bioscience;* **28**: No. 6, 376-382(Jun 1978).

Annual U.S. fossil energy consumption (18×10^{15} kcal) is significantly greater than the total solar energy fixed by all plant biomass in the United States (13.5×10^{15} kcal). Total annual solar energy conversion by agriculture and forestry biomass amounts to 5.8×10^{15} kcal, thus emphasizing the importance of U.S. agriculture and forestry in solar energy conversion. Total annual solar energy conversion by other biomass sources like wastes has a potential of producing 0.34×10^{15} kcal or 1.9% of current fossil energy use.

433 Harness halobacteria as solar batteries. *Bioscience;* **28**: No. 6, 412(Jun 1978).

This brief note discusses the potential for using salt-loving bacteria to generate electricity from sunlight. Bacteriorhodopsin is extracted and used to study the phenomenon. Possible future applications are given.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 436, 885

434 (SAND—78-0956C) Energy storage considerations in photovoltaic central station utility applications. Schueler, D.G.; Jones, G.J. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 5p. (CONF-780808—16). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

The nominal effects of energy storage on cost and performance goals for solar photovoltaic conversion systems intended for large-scale electric utility applications are studied. Specifically, central station photovoltaic power plants having co-located energy storage systems are examined with respect to dispatch modes that either dedicate the energy storage to the plant operation to achieve a given plant capacity factor or treat the energy storage as a utility system asset to be dispatched independent of the solar system. Resultant system economics are treated parametrically with respect to photovoltaic array efficiency, average solar insolation, and energy storage efficiency. It is concluded that dedicated energy storage imposes a severe economic and performance penalty on the allowable cost of photovoltaic arrays for intermediate load utility applications.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 415, 481, 483

435 (SAND—78-8010) **Introductory comparison of Brayton and Rankine power cycles for central solar power generation.** Hiller, C.C. (Sandia Labs., Livermore, CA (USA)). Jul 1978. Contract EY-76-C-04-0789. 51p. Dep. NTIS, PC A04/MF A01.

A detailed discussion of the characteristics of Brayton and Rankine power cycles and a discussion of their advantages and disadvantages as applied to central solar power generation are presented. The characteristics of each cycle are discussed for a variety of configurations and are highlighted with numerous examples. Much of the background information presented is available from standard texts on thermodynamics, gas turbines, and steam turbines. The information has been drawn together in one convenient reference to serve as an introduction for individuals new to the solar research and development area.

436 (TID—28590) **Study of the feasibility of utilizing solar, wind, and geothermal energy in Hobbs, New Mexico. Final report. Volume 2.** Taylor, B.J.; Huettner, D.A.; Murry, D.; Horrell, J.; Ingene, C. (Oklahoma Univ., Norman (USA). Center for Economic and Management Research). 1977. Contract EY-76-S-05-5231. 233p. Dep. NTIS, PC A11/MF A01.

Portions of document are illegible.

The objective of this study was to provide an economic analysis of the various solar options for Hobbs, New Mexico. In so doing, an assessment of the current state of the art in solar research was obtained. Cost estimates were provided assuming capacity 100 MW. These options were: Central Receiver, Cylindrical Trough, Parabolic Dish Non-Brayton, Parabolic Dish Brayton, Fixed Mirror Distributed Focus, Dispersed Photovoltaic ERDA Goal, and Dispersed Photovoltaic Present Quote. Three scenarios were used to analyze all of the solar options relative to conventional fossil systems and nuclear alternatives. A total of thirty-two different options were considered. Results and conclusions are presented. (MHR)

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 482

437 (SAND—77-8513) **Highlights report: solar thermal conversion program central power projects.** (Sandia Labs., Albuquerque, NM (USA)). Nov 1977. Contract EY-76-C-04-0789. 162p. (CONF-770880—). Dep. NTIS, PC A08/MF A01.

From Solar thermal branch semiannual review; Seattle, WA, USA (23 Aug 1977).

This review covers status and plans for Central Receiver Projects, the Thermal Test Facility Project, and the related research and development activities. Progress was reported in the following areas: solar central receiver program accomplishments and plans, Sandia overview, field program management, 10-MW solar pilot plant from a utility point of view, advanced central power systems analysis, central receiver pilot plant design, central receiver-solar thermal power system collector subsystem, central receiver research study, design concept chosen for solar electric plant, Solar Thermal Test Facility, 400 kW solar thermal test facility and steam generating plant, fracture of heliostat facets, air-cycle solar receiver, liquid metal cooled solar central receiver feasibility study and heliostat field analysis, heat pipe central solar receiver, heliostat development for a solar power steam energy supplement, interim structural design standard for solar energy systems components, materials testing for central receiver solar thermal power systems, experimental study of convective losses from solar receivers, and hydraulic stability of solar boilers. (MHR)

TOTAL ENERGY AND HYBRID SYSTEMS

438 (TID—28105) **Application analysis of solar total energy to the residential sector. Quarterly technical status report, July 1—September 30, 1977.** Whaley, T.; Yudow, B.; Malik, N.; Gamze, M.; Foster, B.; Goff, T.; Wurm, J. (Institute of Gas Technology, Chicago, IL (USA)). Oct 1977. Contract EG-77-C-04-3787. 172p. Dep. NTIS, PC A08/MF A01.

A solar total energy system (STES) is defined as an energy system designed to maximize the efficient use of collected solar energy by supplying both the low-grade (low-temperature thermal) and high-grade (electrical and/or mechanical) energy needs of selected applications. ERDA's Solar Total Energy Program is concerned primarily with those solar total energy systems that use heat engine or photovoltaic devices to produce electricity (and/or mechanical work) and apply the residual thermal energy from the conversion process to some useful purpose. The solar total energy is backed up and supplemented to the extent required by conventional fossil-fuel-derived energy for periods when solar-derived energy is inadequate. This project will analyze the application of solar total energy to appropriate segments of the residential sector, determine the market penetration potential for STE systems, and develop criteria for selecting suitable demonstration sites throughout the United States.

OCEAN THERMAL GRADIENT POWER PLANTS

REFER ALSO TO CITATION(S) 412

439 (ANL-OTEC—78-3) **Flow-induced vibration in shell-and-tube heat exchangers for Ocean Thermal Energy Conversion (OTEC).** Lorenz, J.J.; Yung, D. (Argonne National Lab., IL (USA)). Aug 1978. Contract EY-76-C-02-0016. 49p. Dep. NTIS, PC A03/MF A01.

The problem of crossflow-induced vibration in shell-and-tube heat exchangers for OTEC is considered. Models of the dominant excitation mechanisms are discussed: vortex shedding, turbulent buffeting, fluideleastic instability, and acoustic excitation. Criteria are presented for assessing vibration and equations are derived for predicting the maximum allowable span length as a function of crossflow velocity and other system variables. Also regions of acoustic resonance and noise are defined. Among the system variables studied are tube diameter, tube material, tube-field layout, and pitch-to-diameter ratio. All models are presented in a simple form that can readily be applied to the mechanical design of OTEC heat exchangers.

440 (CONF-780236—2) **Chemical, electrochemical, and thermal bridges for transmission of OTEC power.** Biederman, N.P.; Sinnott, J.; Talib, A.; Blazek, C.F. (Institute of Gas Technology, Chicago, IL (USA)). 1978. 54p. Inst. of Gas Technology, Chicago, IL.

From 5. OETC conference; Miami, FL, USA (20 Feb 1978).

Chemical and electrochemical means of providing a "bridge" from an OTEC plant to an energy market offer a number of advantages over electric cable transmission. The most recent work done by the Institute of Gas Technology (IGT) on assessing various forms of chemical, electrochemical, and thermal energy carriers for OTEC plants is reported. These energy carriers were evaluated in terms of their overall technical feasibility and economic potential in the energy marketplace as means for augmenting conventional chemical fuels, providing peaking electric power, and as chemical feedstocks.

441 (COO—2641-5) **Literature survey on vertical tube evaporators (VTE's). Part I. Bibliographical entries.** Rothfus, R.R.; Neuman, C.P.; Lavi, G.H.; Farthing, G.A. Jr.; Prengaman, R. (Carnegie-Mellon Univ., Pittsburgh, PA (USA)). Jul 1977. Contract EY-76-S-02-2641. 56p. Dep. NTIS, PC A04/MF A01.

A bibliography of the literature pertinent to vertical tube heat exchangers for OTEC application has been prepared. More than 200 references from different sources (journals, books, companies and government reports) on heat exchanger design, operation and performance have been identified and surveyed for a two part report on the state-of-the-art of vertical tube evaporators. This bibliography represents Part I. Each bibliographical entry has been coded to facilitate references to particular articles in the narrative account of the survey represented in Part II.

442 (ORAU/IEA—78-11(O)) **Ocean thermal energy conversion.** Pollard, W.G. (Institute for Energy Analysis, Oak Ridge, TN (USA)). Jun 1978. Contract EY-76-C-05-0033. 10p. Dep. NTIS, PC A02/MF A01.

Ocean thermal energy conversion (OTEC) systems are briefly described, as well as some of the engineering problems encountered in their development. Such systems utilize stable thermal gradients in tropical oceans for thermal input to a closed cycle for electric generation. Thermal-to-electric conversion efficiencies on the order of 2% are contemplated. Large areas of heat exchangers in marine service are required, and primary objectives of government R and D are concerned with biofouling and corrosion of heat exchanger surfaces and materials. Transmission of power from the floating OTEC station at sea to load centers on land is by submarine cable or liquid hydrogen for longer distances. A general description and assessment of OTEC systems is provided to judge their future utilization in electric utility systems. A bibliography of detailed studies and engineering designs is provided for those desiring more specific assessments of particular aspects.

443 **Ocean thermal energy conversion: legal, political and institutional aspects.** Knight, H.G.; Nyhart, J.D.; Stein, R.E. (eds.). Lexington, MA; D.C. Heath and Co. (1977). 258p. $19.00.

The chapters can be grouped into three headings: nonlegal issues, international legal aspects, and domestic regulation. These chapters are: Ocean Thermal Energy Conversion (OTEC) Plants: Technical Background; An Economic Assessment of Ocean Thermal Energy Conversion; International Jurisdictional Issues Involving OTEC Installations; International Political Implications of Ocean Thermal Energy Conversion Systems; Spatial and Emerging Use Conflicts of Ocean Space; International Regulatory Authority Concerning Ocean Thermal Energy Conversion Devices; International Environmental Aspects; Problems of Legal Responsibility and Lia-

bility to Be Anticipated in OTEC Operations; Ocean Thermal Energy Conversion Plants: Federal and State Regulatory Aspects; Ocean Thermal Energy Conversion: Domestic Environmental Aspects; and Legal Aspects of Financing Ocean Thermal Energy Plants. (MHR)

SOLAR RADIATION UTILIZATION

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 414, 885, 904

444 (ANL/EES-CP—14) **Reliability, maintainability, and materials performance of solar demonstration systems.** Chopra, P.S. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 9p. (CONF-780701—1). Dep. NTIS, PC A02/MF A01.

From Conference on the energy solar updates; Atlanta, GA, USA (12 Jul 1978).

The Department of Energy (DOE) is conducting the National Program for Solar Heating and Cooling of Buildings. A major element of that program is the National Solar Data Program which includes data collection, evaluation and report publication. Information and technical data are being collected and reported on a number of residential and commercial sites. Recently, a program was initiated at Argonne National Laboratory (ANL) under the auspices of the National Solar Data Program to collect, evaluate, and publish reliability, maintainability, and material performance data from these sites. The plans which have been made and some of the early results which can be expected from the ANL Solar Data Program are described. (WHK)

445 (BNL—24517) **Development of a cost-effective solar assisted heat pump system.** Andrews, J.W. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 9p. (CONF-780808—12). Dep. NTIS, MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

Portions of document are illegible.

A program of research and development is in progress whose goal is the development of a cost-effective solar assisted heat pump system. The results of computer simulations of the system being developed under this program are presented. The system has as its central element a highly efficient water-source electric-power-driven vapor-compression heat pump. This heat pump will be supplied with thermal energy by low-cost collectors, with a low-temperature storage element serving as a buffer between the collectors and the heat pump. Operation of collectors and storage in the 5 to 40°C (40 to 100°F) temperature range will allow significant reductions in the cost of these components. These same components accommodate cooling very efficiently. The heat pump extracts heat from the air-conditioned space during the day, and the system rejects the accumulated heat from storage at night to the cooler outside ambient. The effect on system performance of varying collector characteristics is presented.

446 (BNL—24573) **Role of the vapor compression cycle in solar energy utilization.** Kush, E.A. Jr. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 5p. (CONF-780808—14). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

The vapor compression cycle lends itself to solar energy utilization in two important ways. Its ability to utilize a relatively low temperature heat supply to produce space heating via heat pumps allows the use of solar input to the evaporator to provide potential Coefficients of Performance which are 2 to 3 times higher than present electric driven heat pumps, and the use of relatively inexpensive solar collectors is possible since the collection temperatures can be low grade. Secondly, the compression process of the vapor cycle can be powered by a solar-driven heat engine, typically using a Rankine cycle, for solar cooling purposes. Discriminating coupling of solar with vapor compression allows the well-developed technology and manufacturing capability of the vapor compression industry to be brought into play in the solar field, widening its base and promoting its diversification. The cycle thermodynamics, potential practical hardware, and R and D projects in both of these areas are reviewed. Particular attention is given to the Solar Assisted Heat Pump and its characteristics and the heat pump simulator activities at Brookhaven National Laboratory.

447 (BNL—24579) **Potential for ground coupled storage within the series solar assisted heat pump system.** Metz, P.D. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 5p. (CONF-780808—13). Dep. NTIS, MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

Portions of document are illegible.

The potential for ground coupling in the series solar heat pump system is explored. The ground is a thermal medium of high heat capacity, low conductivity, and a heat source and sink of virtually limitless extent. Throughout the continental United States, the natural ground temperature a few feet below the surface normally averages about 55°F. Thus, the ground is a plausible additional element useful in solar heat pump systems. This new resource permits seasonal energy storage and transfer. That is, during the summer and fall surplus energy is delivered to the ground by the solar collectors which are otherwise unused. This energy is partially retrieved during the winter season. Significantly reduced collector area results. Likewise, heat deposited in the ground acts as a "buffer" to keep the water storage temperature above 40°F so that expensive resistive heating is not used. Various ground coupling schemes are explored. Previous results and original computational models are discussed. Cost-effectiveness is emphasized heavily and the near term possibility of an economically viable solar heating system via ground coupled storage within the series solar heat pump system is projected.

448 (EPRI-ER—808-SY) **Solar heating and cooling of buildings (SHACOB): requirements definition and impact analysis.** Cretcher, C.K.; Melton, W.C. (Aerospace Corp., El Segundo, CA (USA)). Jun 1978. 82p. Dep. NTIS, PC A05/MF A01.

The installation of Solar Heating and Cooling of Building (SHACOB) systems usually requires a backup system—often electric—to take some portion of the load on days of low insolation, and to carry the entire load during extended periods of low insolation. The implications of such systems on the economic operation of electric utilities may be significant if a displacement of required generating capacity does not accompany the displacement of energy. The objective of this study was to assess the economic impact of various SHACOB design concepts on the electric utilities and their customers and to define system requirements for optimizing this impact. Weather and insolation inputs for simulations were established for locations across the United States. Reference buildings and their thermal properties were defined according to ASHRAE 90-75 standards, and detailed internal and external load models generated to characterize building thermal performance. The TRNSYS program was modified to simulate the performance of both solar and conventional systems, including load management systems featuring nighttime thermal storage. The systems analyzed in detail were direct solar systems with and without a load management capability, solar assisted heat pumps, and customer load management systems. These systems were evaluated with respect to conventional resistive and heat pump systems. Projections for new buildings and types of heating system installations in those buildings were developed by eight participating utilities for their own service areas. TRNSYS simulations for the various types of systems in a wide variety of building types were used to generate backup electric demand time histories for representative cities in or adjacent to the eight service areas.

449 (EPRI-ER—808(Vol.1)) **Solar heating and cooling of buildings (SHACOB) requirements definition and impact analysis. Final report, June 1978.** Cretcher, C.K.; Melton, W.C. (Aerospace Corp., El Segundo, CA (USA)). Jun 1978. 104p. Dep. NTIS, PC A06/MF A01.

The objective of this study was to assess the economic impact of various SHACOB design concepts on the electric utilities and their customers and to define system requirements for optimizing this impact. Weather and insolation inputs for simulations were established for locations across the United States. Reference buildings and their thermal properties were defined according to ASHRAE 90-75 standards, and detailed internal and external load models generated to characterize building thermal performance. The TRNSYS program was modified to simulate the performance of both solar and conventional systems, including load management systems featuring nighttime thermal storage. The systems analyzed in detail were direct solar systems with and without a load management capability, solar assisted heat pumps, and customer load management systems. These systems were evaluated with respect to conventional resistive and heat pump systems. Projections for new buildings and types of heating system installations in those buildings were developed by eight participating utilities for their own service areas. TRNSYS simulations for the various types of systems in a wide variety of building types were used to generate backup electric demand time histories for representative cities in or adjacent to the eight service areas. The principal findings along with a brief discussion of the assumptions and methodology used in the study are presented.

450 (EPRI-ER—808(Vol.2)) **SHACOB: requirements definition and impact analysis. Final report, June 1978.** Cretcher, C.K.; Melton, W.C. (Aerospace Corp., El Segundo, CA (USA)). Jun 1978. 603p. Dep. NTIS, PC A99/MF A01.

The objective of this study was to assess the economic impact of various SHACOB design concepts on the electric utilities and

their customers and to define system requirements for optimizing this impact. The systems analyzed in detail were direct solar systems with and without a load management capability, solar assisted heat pumps, and customer load management systems. These systems were evaluated with respect to conventional resistive and heat pump systems. Projections for new buildings and types of heating system installations in those buildings were developed by eight participating utilities for their own service areas. TRNSYS simulations for the various types of systems in a wide variety of building types were used to generate backup electric demand time histories for representative cities in or adjacent to the eight service areas. This volume presents a review of the delta demand analyses and results for each of the 12 utility/representative city combinations considered. The analysis itself determined the change in utility demands (delta demands) that would result from the widespread implementation of various types of solar heating systems in an electric utility service area. The results are summarized in several different formats, including 24-hour profiles, distributions at the time of day for utility peak, energy displaced, and an estimate of capacity displaced (since utility operations were not modeled in the delta demand analysis capacity displaced can only be estimated).

451 (EPRI-ER—808(Vol.3)) **SHACOB: requirements definition and impact analysis. Final report, June 1978.** Cretcher, C.K.; Melton, W.C. (Aerospace Corp., El Segundo, CA (USA)). Jun 1978. 142p. Dep. NTIS, PC A07/MF A01.

This volume describes the definition of buildings and HVAC systems developed for the analysis of the impact of solar heating and cooling of buildings (SHACOB) on electric utilities. In addition, the computer simulation models and procedures for determining system performance and service area demand impact are reviewed. The computation of the change in utility demand patterns, as a function of geographic region and season, requires the analytic definition of a variety of building types and solar systems consistent with the physical information required to process the simulation code. The computations must be done for a reference set of buildings equipped with solar heating and cooling systems, and then the same set equipped with conventional HVAC systems in order to determine the differential impact. Within the residential sector, a reference set of buildings was identified which would be representative of single family (detached and attached), multi-family (low-rise and high-rise), and motel occupancies. Within the nonresidential sector, a reference set of buildings was selected which would be representative of office, mercantile (retail store and shopping center), educational (elementary and high school), hospital, and light industrial occupancies. The determination and calculation of specific numerical values required for the parameters input to the simulation code to compute building heating and cooling loads are discussed. For residential buildings, the TRNSYS code was used directly with modifications for solar heat gain through windows, infiltration of outside air, and latent heat gains. However, the simulation of the thermal response of the heavier construction of nonresidential structures and the behavior of secondary HVAC distribution systems required the more extensive thermal loads models provided by the AXCESS computer program.

452 (EPRI-ER—808(Vol.4)) **SHACOB: requirements definition and impact analysis. Final report, June 1978.** Cretcher, C.K.; Melton, W.C. (Aerospace Corp., El Segundo, CA (USA)). Jun 1978. 155p. Dep. NTIS, PC A08/MF A01.

The results of the analysis performed to determine the differential economic impact on electric utility customers resulting from equipment, installation, and operational differences between solar heating and cooling (SHAC) systems and conventional systems are presented. The annualized differential cost to the customer which would result from SHAC penetration of conventional markets is the measure of customer cost impact utilized in the overall economic impact analysis for the utility/customers economic unit. The annualized customer cost can be readily compared to a utilities' annual cost of production savings and annualized capacity credits which result from SHAC applications. Those systems having the most favorable cost impact on the utility/customer aggregate can then be identified. To support the development of annualized costs, a comprehensive assessment was made of the equipment, installation, and maintenance costs for both SHAC systems and conventional heating and cooling systems. The reference solar systems form the basis for estimating the component costs. To obtain the component costs for the solar loop of the systems, specific solar collector array configurations were defined. This established the specific components and the possible ranges of component quality contained in the arrays and their structural supports. Specific system designs were used to determine the required piping and thermal storage components. For each location studied, the total cost of the solar system was first estimated on a per building basis and was then multiplied by the estimated number of new building starts for the appropriate residential market and time period of interest. This was compared to the conventional HVAC costs for the same market. The difference formed resulted in the total differential cost of the aggregated market.

453 (FSEC—77-8, pp 111-118) **Conversion of an existing poultry house to collect solar energy.** Forbes, R.E. (Mississippi State Univ., Mississippi State). Sep 1977.

From Flat-plate solar collector conference; Orlando, FL, USA (28 Feb 1977).

In Proceedings of 1977 flat-plate solar collector conference.

A low-cost solar air heater was constructed on an existing poultry building at Mississippi State, Mississippi. Air flow channels below the galvanized roof were formed by covering the underside of 2-in x 4-in purlins with 1-in polyurethane and $\frac{1}{4}$-in plywood. The galvanized roof was painted with heat resistant flat black paint and glazing was supported $\frac{1}{2}$-in above the corrugation peaks. Total collector area was 720 sq ft; one-half covered with 2 foot by 3 foot double strength glass and one-half covered with 0.060 in 4 foot by 8 foot Lexan. The collector tilt-angle was dictated at 15° by the slope of the roof on the existing structure. The collecting area faced due south. The roof was subdivided into two separate segments in order to compare performance of the glass and Lexan covered sides. Provisions were made to measure the air flow rate in each segment of the roof. Efficiency of the collector system was measured at four air flow rates through the system. The collection efficiency increased linearly with air flow rate with an average efficiency around 30 percent. Curves are presented which indicate performance of the system for a typical day; where ambient temperature, collector exit temperature, and heat collection rate are plotted versus time of day for a given air flow rate. Ambient air was pulled into the collectors during all tests.

454 (LA-UR—78-1571) **Simple technique of estimating the performance of passive solar heating systems.** Balcomb, J.D.; McFarland, R.D. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 6p. (CONF-780808—15). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

A method is presented for estimating the annual solar performance of a building using a passive thermal storage wall of the Trombe wall or water wall type with or without night insulation. Tables of performance parameters are given for 84 cities. The method is accurate to +-3% as compared with hour-by-hour computer simulations.

455 (LA-UR—78-1631) **Comparative economics of passive and active systems: residential space heating applications.** Roach, F.; Noll, S.; Ben-David, S. (Los Alamos Scientific Lab., NM (USA); New Mexico Univ., Albuquerque (USA)). 1978. Contract W-7405-ENG-36. 14p. (CONF-780808—7). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

The economic performance of alternative designs are evaluated. One passive design is emphasized, the thermal mass storage wall. The economic performance of this design is examined and subsequently contrasted with one active design, the air collector/rock storage system. Architectural design criteria, solar performance characteristics, and the incremental solar cost of each design is briefly reviewed. Projections of conventional energy prices are discussed, along with the optimal sizing/feasibility criterion employed in the economic performance analysis. In addition, the effects of two incentive proposals, income tax credits and low interest loans, upon each design are examined. Results are reported on a state-by-state basis, with major conclusions summarized for each design. It is generally the case that incentives greatly enhance the economics of both system designs, although the contrast is greater for the passive design. Also, against the less expensive conventional fuels (natural gas and heating oil) the passive design was shown to offer a more cost effective alternative than the active system for most states.

456 (LA-UR—78-1878) **Comparative economics of passive and active systems.** Roach, F.; Noll, S.; Ben-David, S. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 41p. (CONF-780667—3). Dep. NTIS, PC A03/MF A01.

From Symposium on solar energy; Cairo, Egypt (16 Jun 1978).

As the interest in solar energy applications for residential space heating grows, it becomes imperative to evaluate the economic performance of alternative designs. One passive design is concentrated on—the thermal mass storage wall. The economic performance of this design is examined and subsequently contrasted with one active design—the air collector/rock storage system. Architectural design criteria, solar performance characteristics, and the incremental solar cost of each design is briefly reviewed. Projections of conventional energy prices are discussed, along with the optimal sizing/feasibility criterion employed in the economic performance analysis. In addition, the effects of two incentive proposals—income tax credits and low interest loans—upon each design are examined. Results are

reported on a state-by-state basis for the U.S., with major conclusions summarized for each design. It is generally the case that incentives greatly enhance the economics of both system designs, although the contrast is greater for the passive design. Also, against the less expensive conventional fuels (natural gas and heating oil) the passive design was shown to offer a more cost effective alternative than the active system for most states.

457 (SAND—78-1241C) **Design and computer simulation of solar-heat pump systems.** Hoover, E.R.; Winn, C.B. (Sandia Labs., Albuquerque, NM (USA); Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). 1978. Contract EY-76-C-04-0789. 5p. (CONF-780808—9). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

An "in-line" solar-heat pump heating and cooling system, which uses the solar heated water in storage as its heat source, is designed for installation in a subdivision model home located in Fort Collins, Colorado. The modular simulation program, TRNSYS, developed at the University of Wisconsin-Madison, is used to simulate the system's performance over an entire heating season and to determine the system's sensitivity to several important parameters such as collector size and storage size. The "in-line" system's performance is compared to that of a "parallel" solar-heat pump system, a dual-source solar-heat pump system, a conventional solar heating system, and a conventional air-to-air heat pump system. The results indicate that the "parallel" system's thermal performance is clearly superior to that of the "in-line" system and marginally better than that of the dual-source system.

458 **Solar heating system.** Pies, O.W. US Patent 4,095,584. 20 Jun 1978. Filed date 14 Jul 1976. 4p.

A solar heating system is described which includes a heat accumulating structure and a heat storage pit. A roof of the heat accumulating structure includes a backing board and a corrugated metal plate mounted on and overlying the backing board to form air heating channels between the backing board and the metal plate. Air is directed along the air heating channels to be heated when the sun shines on the metal plate. The heated air is directed from the channels of the roof through the chamber to heat rocks in the chamber.

459 **Uniform solar energy code. 1976 edition.** New York; International Association of Plumbing and Mechanical Officals (1976). 102p. $6.00.

This Solar energy Code is an ordinance providing minimum requirements and standards for the protection of the public health, safety, and welfare. The provisions of the code apply to the erection, installation, alteration, addition, repair, relocation, replacement, maintenance, or use of any solar systems. The following are covered in the Code: administration, definitions, quality and weights of materials, general regulations, piping, joints and connections, tanks, collectors, insulation, duct work, collector sizing and calculations, and conversion table international system of units. (MHR)

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 885

WATER HEATING

REFER ALSO TO CITATION(S) 444, 448, 449, 450, 451, 452, 885

460 (DOE/CS—0042/1) **SOLCOST. A new simplified design method for residential and light commercial solar heating and cooling. Third edition.** (Department of Energy, Washington, DC (USA). Div. of Solar Technology). Jun 1978. Contract EX-76-C-01-2531. 10p. Dep. NTIS, PC A02/MF A01.

An introduction to SOLCOST, how it can be used and what it can do, is provided. The operational and technical details are introduced for those familiar with solar system engineering and computer technologies. (MHR)

461 (DOE/CS—0042/2) **SOLCOST. Third edition.** (Department of Energy, Washington, DC (USA). Div. of Solar Technology). Jun 1978. Contract EX-76-C-01-2531. 17p. Dep. NTIS, PC A02/MF A01.

This design method features heat load calculations, solar versus conventional cost comparison, and solar system sizing. This handbook presents a sample form, explains in detail how to fill out the input forms, shows how to evaluate the SOLCOST output, and gives technical details. (MHR)

OTHER

462 (NP—22862) **Some applications of solar energy in Thailand. Research report No. 61.** Htun, M.N.; Aftab, M.P.; Ramachandran, P.N. (Asian Inst. of Tech., Bangkok (Thailand)). Jun 1976. 90p. Dep. NTIS (US Sales Only), PC A05/MF A01.

Solar energy for process heat is identified as the application with potential for widescale use in rural areas rather than urban centres of Thailand. Three applications of solar energy, namely distillation, drying, and cooking are investigated. The units for the study are designed with low cost, flexibility and durability as the aim. The production efficiency of a conventional solar still is improved by the use of internal or external mirrors. To improve the production and efficiency of a solar still, a suspension of activated carbon particles is introduced into the still. However, the most significant improvement in efficiency and production occurs when the solar still is filled and operated with a static bed of burnt rice husk. The solar dryer, drying tapioca chips can reduce moisture content of around 71% down to 14% within 8 hours of operation. The solar dryer performs more efficiently and effectively than open floor drying. The solar cooker is inconvenient to use and operate and the potential for widescale use is concluded to be remote unless social habits change and the cooker made more comfortable to utilize.

463 **Solar engine.** Schweitzer, E.O. US Patent 4,094,146. 13 Jun 1978. Filed date 7 May 1976. 6p.

A solar engine is described including an air motor driven by a quantity of pressurized hot air from a solar heater vessel and including an air pump for pumping substantially an equal mass of cool air back into the solar heater. The driving action of the air motor and simultaneous pumping action of the pump is accomplished in one embodiment by means of a moving piston which separates the driving and pumping sides of the air motor enclosure, whereby substantially both displaced volumes are substantially equal. Air is used as both the heat transfer means and as the actual working fluid. The engine provides for an unlimited life for the solar collector, and an engine of relatively low friction and substantial simplicity.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 424, 425, 453

464 (LBL—6691(Rev.)) **Structure of a black chrome solar selective surface.** Lampert, C.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1978. Contract W-7405-ENG-48. 6p. (CONF-780808—11). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

The structure of "CHROM-ONYX" type of black chrome/metal selective absorber was studied to gain a better understanding of its influence upon the mechanism of wavelength selectivity. Spectral reflectance measurements were performed on seven samples. The best selectivity was found by these measurements to be 0.7 micron of black chrome on nickel and 1.0 micron of black chrome on copper. Both scanning and transmission electron microscopy were employed to study microstructure and chemical composition. As a result of the combined studies, some effects of black chrome thickness and the metallic substrate were determined. It was found that black chrome consisted of a very fine metallic distribution of particles of chromium, possibly suspended within a matrix of an oxide of chromium. This combination was, in turn, agglomerated into larger particles within the 0.05 to 0.3 micron size range. These larger particles formed a network which constituted the surface coating.

465 (SAND—78-0140C) **Solar averaged transmittance properties of various glazings.** Pettit, R.B. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 6p. (CONF-780808—5). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Section of the International Solar Energy Society; Denver, CO, USA (28 Aug 1978).

The solar average transmittance properties of a variety of coated and uncoated plastics (teflon, tedlar, acrylic) and fiberglass composites (e.g., greenhouse coverings) were calculated from the normal hemispherical transmittance measured from 250 to 2500 nm. In addition, the normal hemispherical reflectance for each sample (which includes the reflectance from both sample surfaces) was measured over the same wavelength range. These data were solar averaged over an air mass two solar spectrum for the following cases: (1) an average over the solar energy spectrum as reported separately by Moon and Thekaekara to obtain a solar transmittance which is applicable to a solar thermal collector; (2) an average over the solar photon spectrum to obtain a solar transmittance which is applicable to a solar photon converter; and (3) an average over the solar photon spectrum which has been limited to the active wavelength region of several common solar cells. Solar energy transmittance values for the materials studied ranged from 0.95 to 0.77. The

solar energy averages calculated using Thekaekara's data were from 0 to 3.5% lower than the averages calculated from Moon's data. Depending upon the material, the difference between the solar energy average and the solar photon average limited to the active range of a solar cell ranged from 1% to as much as 11%. Thus materials that have a low solar energy transmittance (approximately 80%) when used in thermal systems, may have a higher solar photon transmittance (approximately 90%) when used in photovoltaic systems.

466 (SAND—78-0949) **Linear concentrating solar collectors: current technology and applications.** Leonard, J.A. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 36p. Dep. NTIS, PC A03/MF A01.

Linear concentrating collector technology is reviewed. Included are fundamentals of the technology; descriptions of collectors with particular emphasis on the types tested at the DOE/Sandia Midtemperature Solar Systems Test Facility (MSSTF); performance test results; problems identified through operating experience; cost projections; and a discussion of applications of linear concentrating and midtemperature solar collectors.

467 **Combined solar cell and hot air collector apparatus.** Griffiths, K.F. US Patent 4,095,997. 20 Jun 1978. Filed date 7 Oct 1976. 8p.

A solar collector is described having at least one solar cell, an air retaining plate located parallel to and immediately behind the unlit side of the cell. A plate is spaced from the back of the cell to permit passage of substantially all the air that is to be treated by the cell, the retaining plate being in communication with the portion of the collector through which the air is withdrawn.

468 **Solar energy collector with on site storage.** Oquidam, B. (to Compagnie pour l'Etude et la Realisation de Combustibles Atomiques). US Patent 4,095,585. 20 Jun 1978. Priority date 30 Dec 1975, France. 4p.

In a solar energy collector with on site storage, the storage unit is constituted of two insulating panels and, between them, a structure formed of two corrugated walls which are joined on one part of their surface, the whole assembly defining three separate volumes. One of the volumes is connected with the free space between the storage unit and a forward partition and constitutes with it the primary circuit. Another volume is connected with the user and constitutes with it the secondary circuit.

469 **Solar heat collector.** Young, S.W. US Patent 4,094,300. 13 Jun 1978. Filed date 21 Jun 1976. 4p.

A solar heat collector having a collector element made from interconnected tubular members, each of which is provided with a transverse baffle, the baffles have openings forming spillways over which heat exchanging liquid passes. The collector element is preferably made from a plurality of tandem arranged sheet metal soft drink or beer cans, the ends of certain cans being removed before the cans are assembled. One or a plurality of collector elements are disposed along an incline such as a roof and a pump feeds liquid to the upper end or ends of the inclined collector element or elements to cascade down through each element and be heated by heat absorbed into the metal from the sun's rays. The heated liquid is then fed through a pipe or pipes from the lower end of each collector.

470 **Solar collector panel.** Sorenson, E.F.; Sorenson, E.F. Jr. US Patent 4,094,301. 13 Jun 1978. Filed date 19 Mar 1976. 6p.

Heat absorbing sheet sections are described with corrugated surfaces terminate in part cylindrical flanges. The flanges are pressed between spaced heat collection tubes and held in place by spring action. The combined structure forms a heat absorbing surface and is secured within a pan having integral bottom and upraised sides. A seal molding is secured on the upraised sides of the pan and mounts two glass panels over the heat absorbing surface. A peripheral slot is formed in the seal molding. A key is pressed fit into the peripheral slot to hold the glass panels and molding in position.

471 **Solar heat collecting units.** Keyes, J.H. (to International Solarthermics Corp.). US Patent 4,088,117. 9 May 1978. Filed date 24 Jun 1976. 8p.

A solar heat collecting plate as part of an assemblage of the plates is adapted to be used in a solar heat collector for solar furnaces and the like and is designed so that the solar collector can be oriented at any angle relative to the angle of the sun. Several embodiments of the heat collecting plate are disclosed but principally each includes an inner plate portion adapted to protrude generally perpendicularly away from a back support wall of the solar collector and an outer plate portion forming an obtuse angle from the outer edge of the inner plate portion. One surface of the outer plate portion is reflective to solar radiation while the other surface of the outer plate portion and both surfaces of the inner plate portion and the back wall of the solar collector are absorptive of solar radiation. When the collecting plates are assembled on the back support wall of the solar collector in spaced parallel relationship, solar radiation is trapped either within or between adjacent collecting plates virtually eliminating radiative losses from the solar collector. In one embodiment, the outer plate portion is pivotally connected to the inner plate portion to selectively optimize the capture of the solar radiation dependent upon the angle of the sun.

472 **Solar energy concentrator.** Lapeyre, J.M. (to Laitram Corp.). US Patent 4,088,121. 9 May 1978. Filed date 19 Jan 1977. 6p.

A solar energy concentrator is described having an array of horns each having converging reflecting surfaces which provide a multiple reflective path from a relatively wide entrance aperture exposed to incident solar energy and a smaller exit aperture from which intensified energy emanates. The energy received from the exit apertures of the horn array is of higher density than the incident energy density and can be used as heat or converted to electrical or other form of energy for use.

473 **Heat exchanger.** Benseman, R.F. (to Development Finance Corp.). US Patent 4,088,118. 9 May 1978. Priority date 28 Jan 1975, New Zealand. 6p.

A panel type absorber of radiant energy, applicable in particular as a solar collector, is formed of two shallow trays sealed together as a box. Energy absorbed at one face is conveyed by convection of primary fluid to a heat exchanger integral with the box and consisting of one or more pipes, horizontal or vertical, which convey a secondary fluid to be heated. Air is excluded from the primary fluid to minimize corrosion.

474 **Radiant energy collector.** Pastor, J. US Patent 4,088,116. 9 May 1978. Filed date 6 Jan 1976. 14p.

A radiant energy collector is described having a generally scroll-shaped configuration and exhibiting a hemispheric energy acceptance angle. Substantially all diffuse and direct radiant energy which is incident on a reflective surface of the collector is reflected toward an elongated energy conversion means. In one arrangement the energy conversion means comprises a fluid container in which a transfer fluid is heated. In another arrangement, the energy conversion means comprises means for converting incident radiant energy into electrical energy.

475 **Solar energy heater.** Tomchak, S.A. US Patent 4,085,728. 25 Apr 1978. Filed date 16 Aug 1976. 6p.

An improved, modular, solar energy converting unit is described which operates as a solar heater. The modular heater incorporates upper and lower surfaces and a prescribed chamber therebetween. The chamber is defined by a plurality of walls or baffles which are substantially parallel and, alternately, extend from opposite sides of the modular unit. In addition, a sinuous, continuous rib member is arranged intermediate adjacent areas of said baffles while providing an interconnection which is spaced from the free end of alternate ones of the baffles. Each of the side walls includes portions which may be selectively interconnected with other portions of adjacent modules. In addition, each of the side walls includes means for aligning and interlocking adjacent modules. Additional support members are provided, to the extent necessary, wherein the module is capable of supporting substantial weights and may be used as a surface decking or the like.

476 **Solar energy conversion system.** Weir, R.L. US Patent 4,085,731. 25 Apr 1978. Filed date 10 Mar 1976. 12p.

A solar energy conversion system is described that provides for complete utilization of the solar energy impinging on solar collectors by having cylindrical lens type collection panels. This system can be used with separate heat sinks with fluid retained at different temperature levels activated to provide domestic water heating, hydronic building heating, and power generation by utilization of temperature differentials in the heat sumps and the generation of hot air pressure and flow within the panels, accomplished by special application of intermittent flow of both fluid and gas through the panel system.

477 **Solar air heater.** Schmidt, R.N. (to Honeywell Inc.). US Patent 4,085,729. 25 Apr 1978. Filed date 10 Nov 1976. 6p.

An improved low-cost solar air heater is disclosed which utilizes an array of holes or jets in an intermediate solar window to produce impingement of the air on the upper or solar energy absorbing surface of the absorber plate to enhance heat transfer efficiency and reduce convection losses from the system.

478 **Method and apparatus for heating a liquid using solar energy.** Hysom, E.E. US Patent 4,085,732. 25 Apr 1978. Filed date 7 Jun 1976. 6p.

A method and apparatus is described for heating a liquid using solar energy. Through the use of an absorber plate made of a sheet of copper or any other similar conductive metal, the heat from the sun is captured. The front surface of the plate is covered with a dark absorbent coating. The heat absorbed by the copper sheet is conducted to a thin film of liquid such as water which is fed by

gravity down the backside of the plate from a supply line disposed adjacent to the top of the backside of the plate. The liquid absorbs the heat from the plate as it flows downward covering the backside of the plate and is discharged at the bottom of the plate into a drain line. The drain line removes the heated liquid from the apparatus.

479 **Solar-radiation collection apparatus with tracking circuitry.** Kaplow, R.; Frank, R.I. (to Massachusetts Inst. of Tech.). US Patent 4,086,485. 25 Apr 1978. Filed date 26 May 1976. 10p.

The invention contemplates improved apparatus for collecting solar radiation and directionally concentrating the same upon utilization means such as a photovoltaic cell system. In the form described, arrayed collecting devices are mounted for individual tracking of maximum solar-energy response at each such cell system, utilizing time-shared access to a microprocessor, and correctional-drive signals uniquely appropriate to the orientation of each collecting device are supplied by the microprocessor on a time-shared basis for the respective components of orientation correction drive means for each collecting device. Since each collecting device is thus automatically correctively positioned for maximum output of its own utilization device, there is an avoidance of precision requirements (a) as to mounting the several collecting devices with respect to each other and (b) as to basic drives to anticipate relative aspect of the sun, as a function of the time of day, or the day of the year, and whatever the earthbound location of the apparatus.

480 **Bulb-type solar energy collector.** Pei, Y.K. (to Owens-Illinois, Inc.). US Patent 4,084,576. 18 Apr 1978. Filed date 3 May 1976. 10p.

There is disclosed a molded glass bulb-type solar collector which includes a parabolic specular reflector member and integral glass tubular member closed at the inner end extends along the focal axis of the reflecting surface. A shank portion of the tubular member extends outside the parabolic reflector and is open at the outer end. The tubular wall has its outside surface within the reflector coated with a wave length selective coating. A transparent glass cover plate that is preferably convex (domed) is sealed over the large open end of the reflector at a peripheral flange. The flange is formed to a regular geometric configuration, viz, square, diamond, hexagon, etc., and several of the bulb collectors are fabricated into a curtain wall with these flanges in adjacent relationship. The space within the cover plate and reflector is pumped to a vacuum. The shank portion of the member is connected into an aperture of a manifold. The collectors are connected in series wherein working fluid is carried in a conduit, and at each aperture, a partition extends into the tubular member bisecting it so that the fluid on one side of the partition is diverted in a counterflow path therethrough and back to the conduit on the other side of the partition. In another form of manifold, collectors are connected in parallel, so to speak, wherein two parallel divided passages are provided in the manifold.

HEAT STORAGE

REFER ALSO TO CITATION(S) 447

481 (CONF-770955—, pp 333-345) **Chemical energy storage for solar—thermal conversion.** Poole, D.R.; Smith, R.D. (Rocket Research Co., Redmond, WA). 1977.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

In Proceedings of the second annual thermal energy storage contractors' information exchange meeting.

The overall objective of this program is to evaluate the concept of chemical storage of solar energy on a total system basis. Technical considerations include selection of reactions or reaction sequences which may be useful in reversible-chemical-reaction (RCR) energy storage, evaluation of selected reactions on thermodynamic and kinetic bases, and preliminary design and modeling of energy storage subsystems based on these reactions. By means of a computer model of a solar-thermal, power generation facility (including various RCR energy storage sybsystems), the technical and economic feasibility of extending the solar-thermal conversion (STC) concept to include baseload power generation is being studied. Selection of promising chemical reactions is complete, as well as tabulation of physical, thermodynamic, and kinetic properties for these reactions. At present, 24 potentially useful reactions have been identified for further study, and preliminary estimates of applicable temperature range, storage density, and storage round-trip efficiency for each reaction have been made. Simplified performance and cost models, on a subsystem basis, of each of three types of solar-thermal power generation facility have been generated. Insolation and demand-load models have been generated, on an hourly basis, for each of four locations in the continental United States. At present, these performance and insolation/demand models can be used to predict the required size and performance of a solar-thermal conversion facility for a specified location, plant type, load profile, and storage round-trip efficiency.

482 (CONF-770955—, pp 352-355) **Cyclic catalytic solar energy storage systems.** Wendlant, W.W. (Univ. of Houston, TX). 1977.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

In Proceedings of the second annual thermal energy storage contractors' information exchange meeting.

The goal of this preliminary study will be to optimize the process stages of the EVA-ADAM concept of energy storage and transmission and to determine the process parameters at the steam reforming--liquid sodium solar tower receiver end. This will provide not only an indication of the feasibility of the system but also establish the range of temperatures, pressures and composition to be encountered by the reforming catalyst.

483 (CONF-770955—, pp 356-361) **Development of operational chemical cycles for the storage of energy.** Wentworth, W.E. (Univ. of Houston, TX). 1977.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

In Proceedings of the second annual thermal energy storage contractors' information exchange meeting.

The overall objective of this program is to find, develop, and demonstrate a chemical reaction cycle which can be used for solar energy storage and regeneration in conjunction with electrical power generation systems which operate within the temperature range 450 to 500°C. In particular, the thermal decomposition of ammonium hydrogen sulfate (NH_4HSO_4) into ammonia (NH_3), water (H_2O), and sulfur trioxide (SO_3) is being investigated for the energy storage step: $NH_4HSO_4 \rightarrow NH_3 + H_2O + SO_3$, and the reverse recombination reaction: $NH_3 + H_2O + SO_3 \rightarrow NH_4HSO_4$ for the energy regeneration step. The overall cycle has high energy storage density and should be operable at the desired temperature. The program includes the efforts of three research groups which work separately but coordinate their efforts and planning through bi-weekly meetings. The project status is reviewed.

484 (CONF-770955—, pp 365-372) **Thermal energy storage R and D program for solar heating and cooling.** Michaels, A.I. (Argonne National Lab., IL); Sargent, S.L. 1977.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

In Proceedings of the second annual thermal energy storage contractors' information exchange meeting.

Status, problems, and R and D needs in the area of solar thermal energy storage and heat exchange as formalized by a technical assessment of the national solar program are identified. The R and D plan that encompasses these specific problems and needs outlined. Ongoing projects and major accomplishments and future plans that address the problems and needs identified are described. (WHK)

485 **Thermal energy storage tank.** Anzai, S.; Uenishi, A.; Sakamoto, T. (to Agency of Industrial Science and Tech.). US Patent 4,088,183. 9 May 1978. Filed date 30 Mar 1977. 6p.

A thermal energy storage tank charged with a phase changeable thermal energy storage material produces a partial pressure variation due to the flow of a heat transfer medium, when passing through the thermal energy storage material. An attempt is made to provide the uniform phase changeable of the thermal energy storage material by passing the heat transfer medium therethrough, over the throughout of the thermal energy storage material, by providing a variety to the flow direction of the heat transfer medium. For instance, according to the achievement of uniform flow of heat transfer medium in the vertical direction, there may be attained uniform phase changeable both in an upper portion and in a lower portion of the thermal energy storage material.

GEOTHERMAL ENERGY

486 **Technological assessment of geothermal energy exploitation and utilization.** Nishio, M. (Industrial Material Research Institute, Japan). *Kogyo Gijutsu;* **18**: No. 12, 37-41(1977). (In Japanese).

With regard to the development and utilization of geothermal energy, the following questions must be answered: Can it have social and economic significance for the long-term energy strategy of Japan What technological system can support its exploitation and utilization What are the future technological problems which must be solved What is the impact of geothermal development on the lifestyle, social and industrial activities of human beings What are the regional impacts What measures are required for practical application Furthermore, many questions remain about the ultimate scale of

geothermal power generation, and about how the power produced is to be allocated.

RESOURCE STATUS AND ASSESSMENT

REFER ALSO TO CITATION(S) 1428

487 Energy sources of the Earth: the limits of geoscience. Kehrer, P. (BGR, Hannover, German Federal Republic). *Geol. Rundsch.;* **66**: No. 3, 697-711(1977). (In German).

A discussion is presented concerning the results of a study of the world energy-supply, conducted by the Federal Institute for Geosciences and Natural Resources (BGR), Federal Republic of Germany. The total fossil-fuel resource-base is estimated to be about 12.5 Tt(ce) (t(ce) = tons coal equivalent), of which 0.9 Tt(ce) can be considered recoverable at present. Future exploration will be able to transform a substantial part of the resource base into reserves. The first indications of limits on oil and natural-gas supplies are becoming visible, and high grade, low-cost uranium ore is in equally limited supply. Should low-grade uranium ore become economically recoverable, no actual limits can be anticipated. It is assumed that geothermal energy in particular will become increasingly important to the future energy economy.

USA

REFER ALSO TO CITATION(S) 415

NON-USA

488 French geothermal energy resources: possibilities for improvement. Lavigne, J. (Service Geologique National, France); Maget, P. *Ann. Mines;* 57-72(Apr 1978). (In French).

A detailed, quantitative assessment is made of France's geothermal resources. Assuming recoverable resources to be 1/6 of reserves, a realistic estimate would be 1.8×10^{18} cal, or 180 million tons of petroleum equivalent. If fully developed, these resources could yield 6 million tons of petroleum equivalent per annum. The high capital cost of a geothermal production/reinjection doublet (about 8 million Francs in 1977) discourages developers, even if studies prove that the well will produce and represent a substantial long-term saving. The exploitation of available resources would require a drilling investment of 16 billion Francs, a figure which is beyond the capabilities of even a large energy corporation. Consequently, it is imperative that some of the costs be absorbed by the state. Legislation has already been enacted to enable heating contracts to be broken if an alternative energy source is to be installed. However, the following legislative remedies are needed to accelerate geothermal development: present regulations concerning heating networks must be extended to geothermal operations; hot-water transport networks should be made public; and exploration subsidies should be provided, permitting efficient management during early development and expanded drilling activity. These initiatives would remove most technical and administrative barriers to full development of geothermal resources, and would accelerate the commercialization of geothermal energy.

489 Meager Mountain, B.C.: a possible geothermal energy resource. Ottawa; Energy, Mines and Resources (1978). 21p.

Meager Mountain is a volcanic complex located 160 km north of Vancouver, B.C., it was selected as a potential geothermal resource area after general studies of western Canada. The dacite and andesite lava domes and associated pyroclastics in the areas are products of more than 4 million years of intermittent activity, the most recent occurring about 2440 b.p. Geochemical studies of the natural hot-springs indicate relatively high temperatures in the local hydrological system. Six boreholes in the surrounding quartz-diorite of the Coast Plutonic Complex indicate extensive circulation of warm water through fractures. The original explosive eruption produced basal explosion breccia and extensive fracturing in the granitic basement. This open fracture system may subsequently have healed itself, producing a reservoir. Twelve figures, four tables, and 18 references are provided.

490 Status and future of geothermal resources and exploration in Japan. Aibe, Y. (Japan Geothermal Development Center). *Doryoku;* No. 141, 87-91(1977). (In Japanese).

Beginning in 1973, geothermal exploration programs of the Agency of Natural Resources and Energy and the Agency of Industrial Science and Technology were combined and included in the Sunshine Project. As a result of the 'oil crisis' of 1973, the budget for geothermal exploration was expanded and has continued to grow. In 1974, 2.8 hundred-million yen were allocated to geothermal programs; by 1976 11.0 hundred-million yen were allocated and in 1977 the figure had reached 14.0 hundred-million yen. By June, 1977, a total capacity of 118 MW (76 MW operational) had been installed at Matsukawa, Otake, Onuma, Onikobe, and Hatchobaru geothermal fields, and two more 50 MW plants were under construction, one on Hokkaido and another in Iwate Prefecture. When completed, the new plants will bring installed generating capacity to 220 MW. Japan will then rank fifth in the world in terms of domestic exploitation, but first with regard to turbine generators. Long-term projections of the Energy Committee of the Economic Planning Agency show an estimated electrical production of 145 GW to be possible, using geothermal steam (based on resource estimates). The geothermal subcommittee of the Industrial Technology Council has estimated that, should hot-dry-rock and super-deep volcanic systems be exploited, the power potential may be as high as 48 TW.

491 Completion of high temperature geothermal steam well in China. Motojima, K. (Geol. Survey of Japan). *Chinetsu Gijutsu;* **2**: No. 4, 59-59(1977). (In Japanese).

Since 1976, the 1243rd Excavation Group of the Xichang Geological Bureau has been conducting a geothermal exploratory survey in the area of the Chiangtang Plain and in the Yangpating area. Drilling in the Yangpating region resulted in a successful steam well. The well produces steam with a temperature of 150°C. The steam column reaches an altitude of 40 m when the wellhead is open. Hot water at a temperature of 84°C is also produced. The success of this well demonstrates the significance of Yangpating as a geothermal resource area.

492 Progress in geothermal resource development in Akita prefecture and outlook for the future. Ueda, R. (Akita Prefecture, Japan). *Jinetsu Enerugi;* **2**: No. 4, 8-17(1977). (In Japanese).

The geothermal reservoirs of Akita Prefecture can be divided into three areas according to the distrubtion of Quaternary volcanic groups. These include the northern Hachimantai area, including Hachimantai and Yakeyama, southern Hachimantai, including Ofukadake, Oshiramori, Nyutozan, and Komagatake, and northern Kurikoma, including Kurikomayama, Koyasudake, and Yamabushidake. In the Hachimantai-Onuma area, 6 exploratory wells, 3 production wells, and 3 reinjection wells were drilled prior to 1972. In 1973, the Onuma geothermal power plant was built near the Matsukawa and Otake power plants. Originally, it had an output of 6 MW; with the addition of another 20 t/h steam well the output has been increased to 9 MW. The electricity produced is used by the Akita smelter and several hotels. In the Akinomiya area of the Kurikoma geothermal field, geological, geophysical, and thermal prospecting is underway. In the Yajinosawa area, a 1000 m borehole is being drilled. Plans call for the construction of two 22 MW power plants in the Koyasu area, and the construction of two 38 MW power plants in the Doroyu area. Thus far, 11 exploratory wells have been drilled, and the presence of steam and hot water has been confirmed.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

493 Geysers and geothermal power production. Rinehart, J. S. (Dept. of Mech. Engg., Univ. of Colorado, Santa Fe, New Mexico, USA). *Naturwissenschaften;* **63**: 218-223(1976).

Geothermal areas are complex systems in which the heat and mass transport mechanisms are not completely understood. The study of geysers can contribute to knowledge of these phenomena. Geysers are classified by their gross external morphology: fountain and pool, and columnar or cone. Their functional mechanisms appear to be based on pressure and density gradients which periodically achieve violent non-equilibrium conditions. The principle locations of geysers are in Yellowstone National Park (U.S.), Iceland, Rotorura (New Zealand), and Kamchatka (USSR); the great majority are in Yellowstone National Park, where all types are extant. The activity of geysers is strongly affected by earthquakes, earth-tidal forces, and barometric pressure; no relation has been found between geyser behavior and seasonal precipitation or temperature fluctuations. Tidal forces in particular are reflected in distinct cyclic behavior of geysers. The cycles have semidurnal and diurnal, fortnightly, semiannual, 8.8 and 18.6 year, and 20,000 year components. Annual barometric cycles are also clearly reflected in geyser activity. Exploitation of geothermal resources in New Zealand has all but halted geyser activity in the developed areas. Most of the commercially exploitable geothermal fields are not characterized by surface activity, hence, sophisticated exploration techniques are required. These generally include seismic and heat flow studies, and, more recently, microearthquake monitoring in which the ground noise from known fields is analyzed and used as a baseline. Nineteen references are provided.

494 Hydrogeothermics of a deep aquifer. Vibert, A. *Tech. Sci. Munic. ;* **73**: No. 1, 31-34(1978). (In French).

A series of equations useful for estimating the major parameters of a deep geothermal system is presented. The equations result

from a highly simplified theoretical treatment, and, while they are not rigorous, they yield results of the same order of magnitude as is usually dealt with in hydrological problems. They are useful for developing a general knowledge of a hydrothermal system for which a great deal of hard data are not available. Using information on natural supply and mechanical pumpage, it is possible to derive further information concerning the total capacity of a system, its transitory duration in days, and its overall duration in years. The full theoretical treatment is described, including geological considerations, and the resulting simplified equations are demonstrated with an example of their use.

NON-USA

REFER ALSO TO CITATION(S) 489, 502, 524

495 Spatial correlation between hot springs and microearthquakes in Taiwan. Tsai, Y.B. (Inst. of Earth Sci., Academia Sinica, Taiwan); Liu, H.L. *Pet. Geol. Taiwan;* No. 14, 263-277(Jun 1977).

The majority of hot springs on Taiwan are located along major geological boundaries, and along the inferred boundary between the Eurasian and Philippine Sea plates. Most of the hot-spring areas are characterized by microearthquake activity. A model for deep circulation of hydrothermal fluids is used to explain the apparent correlation of hot springs with geological boundaries and microearthquake activity. Most geological boundaries in Taiwan consist of faults which may extend to great depth. These faults may provide the means for meteoric waters to percolate to depths at which they can be heated. The hot water then would rise through either faults or fractures. The microearthquake activity is probably induced by rising hot-water. Two possible heat sources are proposed: one in which the heat is residual, having been produced by friction during past fault motion, and one in which the heat is provided by igneous intrusions. The second mechanism is probably responsible for heat along the plate boundary and in the Tatun volcanic area. Ten illustrations and twenty-four references are provided.

496 Thermal water of Itamuro Spa (Tochigi-ken). Suzuki, A.; Okada, N.; Hitomi, I.; Uzuka, S. *Utsunomiya Daigaku Kyoikugakubu Kiyo;* **27**: No. 2, 35-45(1977). (In Japanese).

The Itamuro Hot Springs are situated at the foot of Nasu volcano, and consist of about twenty individual springs. The majority of the thermal water is produced from 14 boreholes. Cores taken from the boreholes were used to clarify the local subsurface geology. The basement rock is predominantly granitic and is intruded by rhyolite. It is overlain by Miocene green-tuff and extrusives from the volcano. The springs produce more than 3400 l/min of 45°C water. The water itself is of the simple type, characterized by sodium sulfate. The sphere of influence of the springs is mapped, and several analyses of the water are tabulated. Six references are provided.

497 Observations of exhalations and boiling springs. Yusa, Y. (Hot Springs Res. Assoc. of Oita Prefecture). *Oita-ken Onsen Chosa Kenkyu-kai Hokoku;* No. 28, 26-30(1977). (In Japanese).

Oita prefecture is abundant in hot springs. Those springs present in the areas of geothermal power-plant construction, such as Beppu and Kuju-Otake, have been extensively studied. Work was performed during October of 1976, aimed at collecting data on the springs of the Kawakami area of Yufuin, the Yano area of Kuju, and the Otake and Amagase-Ouchiku areas. In the Kawakami area, 3 boreholes have a discharge of 4,900-5,000 kg/h, including a hot-water/steam mixture. Their total heat discharge amounts to about 600 Mcal/h. In the Chojabara area, borehole No. 8 has a temperature of 88.8°C but produces little water; No. 9 produces steam and hot water (1:1) with a pH of 8.48; No. 10 has a discharge temperature of 118.5°C. No saline waters have been observed in the Chojabara area, where the hottest well (No. 14) produces saturated steam at 135°C, with a pressure of 3.1 kg/cm^2 (0.31 MPa) and a flow rate of 77 m^3/h. At Amagase, a high-temperature zone is present along the Akaiwa River, with attendant production of a large quantity of hot water. Eight references are given.

498 Regional Report of geothermal exploratory investigation. IV. Kirishima area. Nakagawa, S. (Japan Geothermal Resources Development Center). *Jinetsu Enerugi;* **2**: No. 4, 22-50(1977). (In Japanese).

In the Kirishima area, located in the southern portion of Kyushu, geothermal exploratory investigations began in 1955. Detailed surveys were carried out during 1974 and 1975. Three major (structural) boreholes were drilled. Borehole 50-KS-2 yielded a temperature of 186.5°C, but the other two (50-KS-1 and 50-KS-3) had temperatures as low as 50-60°C. However, electrical surveys indicate that a low resistivity zone, closely related to geothermal manifestations in the area, closely follows the NW-SE Ginyu-Yunoike-Tearai tectonic line. The low-resistivity zone is inclined toward the west, indicating that geothermal reservoirs should be penetrated by 50-KS-1 and 50-KS-3 at greater depth. Although 50-KS-2 is located some distance from the tectonic line, the high temperatures indicate that the type of geothermal reservoir common to Yamanoshiro and Tearai is to be found under western Kirishima as well. This would constitute an exceptionally large resource area which should be developed as quickly as possible.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 491, 498

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 498

499 (ALO—3721-3) Terrestrial heat flow studies in Arizona. Quarterly technical progress report, 31 January 1978—1 May 1978. Shearer, C.R.; Reiter, M. (New Mexico Bureau of Mines and Mineral Resources, Socorro (USA)). May 1978. Contract EY-76-S-04-3721. 8p. Dep. NTIS, PC A02/MF A01.

Ten temperature logs satisfactory for heat flow analysis were obtained. Two logs measured in northwest Arizona have temperature gradients of about 50°/km. A deep temperature log obtained in extreme southwest Arizona has a gradient of 38°C/km. Data in southcentral Arizona suggest a region of heat flow slightly above normal for the Basin and Range.

500 Proposal for geothermal resources exploration. Hirakawa, S. (Tokyo Univ., Faculty of Engg., Japan). *Chinetsu Gijutsu;* **2**: No. 4, 1-5(1977). (In Japanese).

The vast majority of geothermal exploration in Japan has been oriented toward the development of shallow reservoirs, located at depths of 1-1.5 km. Structural reservoirs at depths of about 3000 m have not been closely investigated. The heat which can be expected from deep, high-temperature, high-pressure reservoirs is a significant resource, and exploratory wells of 5-10 km depth may be required for their development. Certain aspects of exploration technology will require refinement to achieve this goal. Studies of age determination, thermal metamorphism, thermal properties of rock, hydrogeology, reservoir dynamics, and geophysical prospecting techniques will be needed. A specific requirement will be for special logging equipment capable of detecting steam or hot water issuing from cleavage deep within boreholes. Other logging equipment, including televiewers and high-power electrical-survey instruments will be needed. The research and development of an optimum, fully integrated, geothermal exploration program should be given priority.

501 Experimental study on the steaming ground. Kagiyama, T. (Earthquake Research Inst., Univ. of Tokyo, Japan). *Kazan;* **22**: No. 3, 149-160(1977). (In Japanese).

Recent technology has allowed the development of infrared detectors and thermo-cameras which permit surface-temperature measurements to be made of inaccessible areas such as the floors of volcanic craters. Experiments were performed to develop formulae to be used in conjunction with this type of equipment for heat-discharge evaluations. Fine glass beads were used to simulate a porous medium heated from below. Experiments were performed under dry and saturated conditions. The vertical temperature-gradient, surface temperature, and heat discharge were monitored with thermocouples. The surface was exposed to free air and evaporation was permitted in the wet samples. Convection occurred more readily in the wet condition, and the critical Rayleigh number was about 3.2, possibly due to free boundary effects at the surface. Functions were derived for heat discharge, surface temperature, and cooling coefficient. In wet samples, the heat discharge was more effective and could not be determined by a simple formula, due to evaporative factors. Cooling constants obtained in field studies are generally smaller than the experimental values, probably because of soil inhomogeneity and ground-water movement. Real surface-temperatures have daily variations due to insolation, and the effect of these variations on estimated heat-discharge values is discussed. Thirteen references are provided.

GEOCHEMICAL TECHNIQUES AND SURVEYS

502 Chemical investigation of hot springs in Mt. Akagi region. Kokubu, N.; Okayasu, M. *Denki Tsushin Daigaku Gakuho;* **27**: No. 2, 283-289(Feb 1977). (In Japanese).

Twenty-four samples of natural waters, including six hot and mineral springs, were collected from the Mt. Akagi region of Gunma Prefecture in August, 1970. They were analyzed for the cations: Na, K, Mg, Ca, Fe, and Mn, and the anions: F, Cl, and SO_4, as well as for SiO_2 and evaporative residue. The waters proved to be neutral or

weakly acidic (pH = 6.1-7.4). The temperatures of the springs ranged from 19.0 to 44.5°C. Mutual relationships between the chemical constituents of the springs and natural waters are discussed.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 491, 498

503 (LA-UR—78-1826) **Acoustic methods for detecting water-filled fractures using commercial logging tools.** Albright, J.N.; Aamodt, R.L.; Potter, R.M.; Spence, R.W. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 19p. (CONF-780825—3). Dep. NTIS, PC A02/MF A01.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

The Los Alamos Scientific Laboratory Hot Dry Rock Geothermal Energy Development Project, under the Department of Energy and in cooperation with Dresser Atlas, has conducted single- and dual-well acoustic measurements to detect fractures in the artificial geothermal reservoir at the Fenton Hill New Mexico experimental site. The measurements were made using modified Dresser Atlas logging tools. Signals traversed distances of from 48 to 150 feet between two wells. Signals intersecting hydraulic fractures in the reservoir under both hydrostatic and pressurized conditions were simultaneously detected in both wells. Upon reservoir pressurization, signals along many ray paths were severely attenuated throughout their entire coda. In addition obvious shear wave arrivals were notably absent. The signals were processed to obtain Full-Wave Acoustic, Power, and Normalized Equi-Power Logs. Analysis of these logs identified the effective "top" of a region of hydraulically activated fractures and fractures intersecting the injection well behind casing.

504 (SAN—1380-1) **Research and development of improved geothermal well logging techniques, tools and components (current projects, goals and status). Final report.** Lamers, M.D. (Measurement Analysis Corp., Palos Verdes Estates, CA (USA)). Jan 1978. Contract EG-77-G-03-1380. 60p. Dep. NTIS, PC A04/MF A01.

One of the key needs in the advancement of geothermal energy is availability of adequate subsurface measurements to aid the reservoir engineer in the development and operation of geothermal wells. Some current projects being sponsored by the U. S. Department of Energy's Division of Geothermal Energy pertaining to the development of improved well logging techniques, tools and components are described. An attempt is made to show how these projects contribute to improvement of geothermal logging technology in forming key elements of the overall program goals.

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 486, 488, 522

505 (DGE—3036-1) **Innovation versus monopoly: geothermal energy in the West. Final report.** Bierman, S.L.; Stover, D.F.; Nelson, P.A.; Lamont, W.J. (Bierman (Sheldon L.) and Associates, Washington, DC (USA)). Jul 1977. Contract EG-77-X-01-3036. 794p. Dep. NTIS, PC A99/MF A01.

The following subjects are covered: geothermal energy and its use, electric utilities and the climate for geothermal development, the raw fuels industry and geothermal energy, and government and energy. The role of large petroleum companies and large public utilities is emphasized. (MHR)

506 (LBL—6875) **Value distribution assessment of geothermal development in Lake County, CA.** Churchman, C.W.; Nelson, H.G.; Eacret, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1977. Contract W-7405-ENG-48. 114p. Dep. NTIS, PC A06/MF A01.

A value distribution assessment is defined as the determination of the distribution of benefits and costs of a proposed or actual development, with the intent of comparing such a development with alternative plans. Included are not only the social and economic effects, but also people's perceptions of their roles and how they are affected by the proposed or actual development. Discussion is presented under the following section headings: on morality and ethics; the vanishing community; case study of pre-development planning—Lake County; methodology for research; Lake County geothermal energy resource; decision making; Planning Commission hearing; communication examples; benefit tracing; response to issues raised by the report of the State Geothermal Task Force; and, conclusions and recommendations. (JGB)

507 **Geothermal energy at Creil.** Martaguet, B. (OISE, Creil, France). *Ann. Mines;* 73-74(Apr 1978). (In French).

The majority of technical and financial problems encountered during the development of the geothermal heating system at Creil have been satisfactorily resolved. However, several areas in which the existing legal and regulatory framework is maladapted to this type of development have been identified. These include risks not identified during development, such as those arising from the use of radioisotopes as well tracers; fundamental exploration risks, such as the set 30 year amortization rate without true guarantees for work stoppages or grave losses; complex finances involved with fixed-redemption schemes which penalize the first years of operation; legislative difficulties in determining exploration costs (which may be considered an investment); and difficulties in the administration and maintenance of a system which is not readily categorized in the framework of existing regulatory statutes. Considerations which have been raised by the geological data obtained at Naoilles (near Creil) are of the sort which would be considered negligible by an oil or gas company of national stature, but are an intolerable burden to an organization the size of the Heating Authority at Creil. Hopefully, HLM will act to solve these financial problems in the near future.

ECONOMIC AND FINANCIAL ASPECTS

REFER ALSO TO CITATION(S) 488, 505, 507

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

508 (UCLA—12-1143) **Baseline studies in the desert ecosystem at East Mesa Geothermal Test Site, Imperial Valley, California.** Romney, E.M.; Wallace, A.; Lunt, O.R.; Ackerman, T.A.; Kinnear, J.E. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). Sep 1977. Contract EY-76-C-03-0012. 138p. Dep. NTIS, PC A07/MF A01.

Baseline data reported herein for soil, vegetation, and small mammal components of the East Mesa desert ecosystem represent a collection period from October 1975 to September 1977. Inasmuch as changes in salt balance from geothermal brine sources are of potential impact upon the ecosystem, considerable analytical effort was given to the determination of element constituents in soil, plant, and animal samples. A preliminary synthesis of data was done to investigate the heterogeneity of element constituents among the sampled population and to summarize results. Findings indicate that periodic sampling and chemical analysis of vegetation around an industrialized geothermal energy source is probably the best way to monitor the surrounding ecosystem for assuring containment of any resource pollutants.

509 (UCRL—52247) **GROW1: a crop growth model for assessing impacts of gaseous pollutants from geothermal technologies.** Kercher, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Mar 1977. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

A preliminary model of photosynthesis and growth of field crops was developed to assess the effects of gaseous pollutants, particularly airborne sulfur compounds, resulting from energy production from geothermal resources. The model simulates photosynthesis as a function of such variables as irradiance, CO_2 diffusion resistances, and internal biochemical processes. The model allocates the products of photosynthesis to structural (leaf, stem, root, and fruit) and storage compartments of the plant. The simulations encompass the entire growing season from germination to senescence. The model is described conceptually and mathematically and examples of model output are provided for various levels of pollutant stress. Also, future developments that would improve this preliminary model are outlined and its applications are discussed.

510 (UCRL—80945) **Processing of geothermal brine effluents for injection.** Quong, R.; Schoepflin, F.; Stout, N.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Mar 1978. Contract W-7405-ENG-48. 4p. (CONF-780708—10). Dep. NTIS, PC A02/MF A01.

From Geothermal Resources Council meeting; Hilo, HI, USA (25 Jul 1978).

The handling and disposal of brine effluents is a critical part of any geothermal conversion process. Brine effluents from the San Diego Gas and Electric/Department of Energy--Geothermal Loop Experimental Facility were characterized for particulate concentration and chemical composition. Bench scale tests were conducted with inorganic and organic coagulants as a means of enhancing the sedimentation process for separation and removal of suspended solids, principally amorphous silica. The effects of temperature, retention time, and pH on the precipitation of supersaturated silica, subsequent floc settling properties, and supernatant clarity were also

determined. A design of a pilot scale clarifier now undergoing testing is also described.

BY-PRODUCTS

511 (SAND—76-5755C) **Magma: a potential source of fuels.** Gerlach, T.M.; Modreski, F.J.; Northrup, C.J. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 2p. (CONF-780807—7). Dep. NTIS, PC A02/MF A01.

From 2. world hydrogen energy conference; Zurich, Switzerland (21 Aug 1978).

Magma and hot silicate rocks can be used to produce fuels from aqueous fluids. Fuel generation from injection of aqueous fluids into magmatic environments occurs principally because the FeO content of these systems causes them to be relatively reducing. Thermodynamic and experimental studies indicate that fluids containing 3 mole hydrogen would result from the interaction of water with typical basaltic rock or magma over the temperature range 500 to 1300°C at 100 MPa total pressure. The cumulative hydrogen potentially recoverable from the interaction of water with a cubic kilometer of basalt at these conditions is on the order of 10^{12} moles (2 x 10^{12} grams or 20 km^3 at S.T.P.). Fuel concentrations can be considerably enhanced by the addition of biomass to the injected aqueous fluid. The mid-ocean ridge systems appear to offer the most favorable site for magmatic fuel generation.

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 492

512 **Geothermal energy driven facilities.** Suzuki, M. (Hitachi Plant Eng. and Construction Company, Ltd.). *Kenchiku Setsubi;* **28**: No. 11, 50-55(1977). (In Japanese).

As of 1977, Japan's geothermal power plants were limited to about 50-60 MW. The target figures for 1983 and 2000 are 2 GW and 20-30 GW, respectively. The geothermal fields driving these plants are of the steam type and the hydrothermal type; hydrothermal fields are predominant. At the Kakkonda geothermal power plant in Iwate Prefecture, 500 t/h of steam at 0.7 MPa is required to produce 50 MW of electric power. Simultaneously, about 2000 t/h of hot water are produced, at a temperature of 165°C. This amounts to 200 Gcal of heat energy, given a utilization temperature of 100°C. This is sufficient to supply the heating needs of a city of 200,000. At the Matsukawa geothermal power-plant, the excess steam is used in a heat exchanger to heat river water to 70°C. The water is then piped to a residential area located 6 km from the plant. About 60 t/h of hot water are transferred through plastic pipe to a recreation center, a hotel, and several sanitoriums. The heat exchanger used is of the 'travelling head', shell and tube type.

DESIGN AND OPERATION

513 (COO—4051-24) **Effect of noncondensables on the work output of geothermal-steam systems.** Khalifa, H.E. (Brown Univ., Providence, RI (USA). Div. of Engineering). 1978. Contract EY-76-S-02-4051. 11p. Dep. NTIS, PC A02/MF A01.

The influence of noncondensables on the output work from geothermal steam power plants was studied. Two problems were addressed: the effect of CO_2 on the exergy (available work) of a given mixture of steam and CO_2 and secondly, the effect of CO_2 on the expansion work of an ideal turbine exhausting at a given back pressure. The results in the latter case were modified to account for the influence of CO_2 on the dryness of the exhaust mixture and the corresponding effect on the expansion efficiency.

POWER PLANT SYSTEMS AND COMPONENTS

514 **Binary cycle systems for power generation.** Kawamura, M. (Sunshine Project, Japan). *Netsu Kanri To Kogai;* **29**: No. 11, 45-49(1977). (In Japanese).

Japan has a long history of geothermal energy development, particularly with respect to the use of binary-cycle generating equipment which can utilize relatively low-temperature heat-sources. During 1947 and 1948, the Tone Boring Company operated the Yunosawa experimental plant near the Izu-Atakawa hot springs. This plant utilized benzine as the working fluid. The Sunshine Project has been operating a research and development program which is expected to culminate in the operation of two binary-cycle power-plants by the end of 1977. Each of the plants is to have a 1.0 MW output. They are designed to utilize two different heat sources; hot water, and hot-water/steam. The hot-water driven plant is designed to use Freon R-114 as the working fluid; its heat exchanger is large and relatively inefficient. The hot-water/steam driven plant will use isobutane as the working fluid and has a much higher efficiency, but is complex and somewhat difficult to control. The isobutane plant is also unsuitable for use with gas-rich geothermal wells. After construction is complete and the plants are brought on line, experiments relative to facility enlargement will be conducted. It is hoped that these systems will prove amenable to scaling-up to an output level in the tens of megawatts. Associated research is oriented toward the development of automatic systems for fluid-leakage control and system optimization. Several flow charts and data tables are provided.

515 **Small scale steam turbine for geothermal power plant.** *Chinetsu Gijutsu;* **2**: No. 4, 55-57(1977). (In Japanese).

A geothermal turbine designed by Toshiba for delivery to the Philippine geothermal power-plant at Tiwi is described. The turbine will be used to provide starting power for cooling equipment and compressors. It can also be used to provide power for auxiliary motors and oil-flushing equipment while the main plant is being installed. The turbine is of the portable backpressure type and has a rated output of 1.3 MW. The steam pressure is about 700 kPa at the inlet and 102 kPa at the exhaust. The turbine operates at 7440 rpm, with a reduction to 1800 rpm at the generator. During its design, simplification of maintenance and transport was emphasized. The rotors are of the cantilever type, with a detachable hub with integrated blades. The use of a monolithic blade/hub assembly leads to enhanced strength and reduced weight.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

516 (HCP/T4014—04) **Prospects for improvement in geothermal well technology and their expected benefits.** (Mitre Corp., McLean, VA (USA)). Jun 1978. Contract EG-77-C-01-4014. 138p. Dep. NTIS, PC A07/MF A01.

Performance restrictions on current geothermal drilling technology and their impact on drilling costs are reviewed, with the impact on electric power costs. Sensitivities of drilling costs to changes in drilling performance are analyzed. A programmatic goal for improving drilling performance is offered. The likely cost savings to the nation if the goal is attained are estimated though the use of a geothermal well drilling scenario for the 1978 to 1990 period, which was derived from DOE's geothermal power on-line scenario. The present worth of the expectd savings stream (benefit) is offered as a point of departure for justifying programmatic costs for improving drilling technology.

517 (SAND—78-1365C) **Workshop on magma/hydrothermal drilling and instrumentation.** Varnado, S.G.; Colp, J.L. (eds.). (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 72p. (CONF-7805104—(Summ.)). Dep. NTIS, PC A04/MF A01.

From Workshop on magma/hydrothermal drilling and instrumentation; Albuquerque, NM, USA (31 May 1978).

The discussions, conclusions, and recommendations of the Magma/Hydrothermal Drilling and Instrumentation Workshop, Albuquerque, NM, May 31—June 2, 1978 are summarized. Three working groups were organized as follows: Drilling Location and Environment, Drilling and Completion Technology, and Logging and Instrumentation Technology. The first group discussed potential drilling sites and the environment that could be expected in drilling to magma depth at each site. Sites suggested for early detailed evaluation as candidate drilling sites were The Geysers-Clear Lake, CA, Kilauea, HI, Long Valley-Mono Craters, CA, and Yellowstone, WY. Magma at these sites is expected to range from 3 to 10 km deep with temperatures of 800 to 1100°C. Detailed discussions of the characteristics of each site are given. In addition, a list of geophysical measurements desired for the hole is presented. The Drilling and Completion Group discussed limitations on current rotary drilling technology as a function of depth and temperature. The group concluded that present drilling systems can be routinely used to temperatures of 200°C and depths to 10 km; drilling to 350°C can be accomplished with modifications of present techniques, drilling at temperatures from 350°C to 1100°C will require the development of new drilling techniques. A summary of the limiting factors in drilling systems is presented, and recommendations for a program directed at correcting these limitations is described. The third group discussed requirements for instrumentation and established priorities for the development of the required instruments. Of highest priority for development were high resolution temperature tools, sampling techniques (core, formation fluids), chemical probes, and communications techniques. A description of instrumentation requirements for the postulated hole is given, and the tasks necessary to develop the required devices are delineated.

518 Excavator for exploiting geothermal energy. Sugii, T. (Tokiko Co., Ltd., Japan);Suzuki, T. (to Tokiko Co., Ltd.). Japanese Patent 1978-5,961. 3 Mar 1978. Filed date 20 Jul 1974. 3p. (In Japanese).

A patent was issued for a boring device which is particularly applicable to geothermal well excavation. The end of a cylindrical drill-stem is fitted with an excavation bit with cutting blades on its tip. The bit is hollow and is fitted with a concentric inner tube which extends through the bit and is open at the tip. The space between the outer shell and the inner tube is filled with a working fluid and is evacuated. The inner space serves to conduct heat by taking advantage of the transfer of latent heat attendant upon the evaporation and condensation of the working fluid. Using this type of excavator, the time between boring of a hole and cementing its walls is reduced, and the overall drilling time is significantly shortened, due to the highly effective transfer of heat away from the drill bit and stem.

519 Fracture mechanism of rock at elevated temperature by wedge bit and roller cutter. IV. Mechanical fracture of rock by cutter. Kuriyaga, M. (Natl. Res. Inst. for Pollution and Resources, MITI, Japan); Misawa, S.; Hayamizu, H.; Kaneko, N. *Nippon Kogyo Kaishi;* **94**: No. 1080, 69-76(1978). (In Japanese).

In order to clarify the fracture mechanisms of hot rock to assist in the development of geothermal energy resources, elevated-temperature excavation-tests were performed with a wedge bit. The results indicate that the load required to create a shear crack, and the crater morphology resulting from wedge penetration, agree well with theoretical predictions (in tests with sandy tuff and Sanjome andesite). In heated marble (above 200°C), tensile cracks were generated, also agreeing with predictions. Cutting tests were performed with gear cutters, using a linear cutting apparatus equipped with an electric furnace. The samples were tested at 200°C, 400°C, and 600°C. During the experiments, the cutter load was maintained at 500 kg and the crater depth and tangential cutter force were measured. The crater shape was compared to the theoretical fracture paths developed by wedge-bit penetration and good agreement was found.

520 Studies of excavation and crushing technology for hot-dry-rock. Takaoka, S. (Natl. Research Institute for Pollution and Resources, Japan). *Chinetsu Gijutsu;* **2**: No. 4, 14-19(1977). (In Japanese).

Several techniques for the drilling and crushing of hot-dry-rock were studied. These included the use of a hemispherical crushing bit to be used in conjunction with a regular rotary drilling system, and the use of pneumatic hammers for down-hole drilling. Also studied was the use of an electrical subterrene penetrator. The dynamic properties of rock which is being drilled or crushed were examined. The results of these studies indicate that the resistance to degradation of Sawairi granite decreases with increasing temperature; that the resistance of Kofu andesite increases with temperature; and that the resistance of Eji andesite remains more or less static with increasing temperature. The subterrene penetrator experiments involved the use of a synthetic graphite heating element having an outside diameter of 7 mm and an inside diameter of 5 mm. The element was 72 mm in length and was fitted within a molybdenum excavation head with a 50 mm outside diameter. The head was heated to 1350°C and was forced into a specimen of sandy tuff under a pressure of 1.5-1.7 t. The resulting cutting rate was about 15-20 mm/min.

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 510

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

REFER ALSO TO CITATION(S) 520

521 Fracturing of rock at elevated temperature by borehole cooling. Hayamizu, H.; Kobayashi, H.; Matsunaga, I. *Nippon Kogyo Kaishi;* **93**: No. 1077, 863-868(1977). (In Japanese).

Theoretical and experimental studies were used to elucidate the mechanism of fracture operative under thermal stress caused by the circulation of cold water through a borehole sunk in hot-dry-rock. Boreholes of 6 cm diameter were drilled through cubic rock-specimens (30 cm sides). The specimens were gradually heated to temperature in an electric furnace and then were rapidly cooled by passing water through the holes. The results indicated that the primary fracture-agent was the tangential stress around the hole when the temperature differential between borehole and specimen exterior reached about 50°C. In specimens of Kofu andesite, cracks resulting from the radial and axial stresses were occasionally found. It was concluded that theoretical calculations of the thermal differential required for fracturing are adequate for practical applications, even though they differ somewhat from experimental results. Mathematical estimates show that hot-dry-rock at a depth of 5000 m will be fractured if the temperature around the borehole is reduced by about 280°C relative to the original temperature.

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 507, 512

522 Action of public authorities for the development of geothermal energy in France. Colli, J.C. *Ann. Mines;* 53-56(Apr 1978). (In French).

In 1974, the French Government launched an incentive program for geothermal development. Existing utilization (1978) comprises the space heating of about 20,000 dwellings. The psychological, technological, and economic barriers to increasing geothermal utilization are discussed. Present plans for development call for the heating of 800,000 to 1 million dwellings by the year 2000. A three year study has concluded that geothermal energy should be utilized where produced, thus becoming decentralized and involving local initiatives and essentially local autonomy of operation. This runs counter to the historical trend of centralization in the control of utilities. Thanks to the cooperation of several agencies, geothermal energy has moved from a probationary period to one of industrialization. Rapid development of geothermal energy is necessary to reduce dependence on imported fuel sources. The high initial capital investment required for geothermal installations makes the development of effective financing systems on a global scale imperative. Due to the rise in energy costs, long-term integration of short-term calculations becomes more important when calculating energy balances. A society, GEO-CHALEUR, has been set up within the national HLM to assemble the requisite number of users, establish an executive and working class, and establish technical and financial support. To attain the goal of 1 million dwellings by the turn of the century, it will be necessary to begin retrofitting existing dwellings. To facilitate this end, a law was passed on July 19, 1977, stipulating that existing heating contracts may not interfere with the installation of new types of equipment. The three-year program has been most successful in identifying resources and barriers to development.

523 Geothermal center at Creil. Delandes, J. *Ann. Mines;* 75-82(Apr 1978). (In French).

The geothermal project at Creil was originally conceived to provide space heating for a total of 4000 housing units, half of which were already completed. The existing dwellings were fitted with heating coils in the floors. 270 m^3/h of water are produced at about 56°C. A system of heat exchangers and heat pumps extracts most of the heat energy remaining after the water passes through the coils in the old units; the heat is then passed to heating systems in the 2000 new units. The 'balance sheet' for the operation shows that, even with occasional assistance from gas and oil backup systems, it is profitable, particularly in terms of the savings in conventional fuels. The operation cannot be easily characterized, as each individual unit is designed differently in order to optimize the efficiency of the system, and to match the design of the individual housing unit. The success of the operation at Creil, particularly in view of the apparently unfavorable balance of ambient temperature and relatively low-temperature water, lends great weight to arguments in favor of expanded development of geothermal energy resources in France.

GEOTHERMAL DATA AND THEORY

REFER ALSO TO CITATION(S) 494

PROPERTIES OF MINERALS AND ROCKS

524 (NP—23254) Studies of physical and chemical characteristics of rocks in geothermal fields. (Akita Univ. (Japan). Coll. of Mining). Apr 1977. 7p. (In Japanese). TIC.

Studies were made of the variation of specific electrical resistivity and magnetic characteristics of rocks caused by hydrothermal alteration. These studies were performed between 1974 and 1977. The variation of specific resistivity is strongly affected by the acidity of the water involved. Altered rock had a markedly lower resistivity than unaltered rock. Soil temperature measurements in geothermal walls have indicated that the soil temperature distribution tends to reflect the basement structure, particularly faulting and lithofacies distribution. Triple-vector magnetic studies showed that electrical charges tend to be concentrated around areas of low specific resistivity which have been subjected to hydrothermal alteration. Artificial magnetotellurics are useful in geothermal exploration. In the geothermal fields located in the 'green tuff' areas of Japan, with the exception of Matsukawa, the minerals laumontite and wairakite are closely related to hydrothermal alteration process-

es. At the Hachimantai and Onuma geothermal fields a large variety of zeolites are encountered, but laumontite and wairakite appear to be most closely related to hydrothermal processes.

ROCK-WATER-GAS INTERACTIONS

REFER ALSO TO CITATION(S) 524

WIND ENERGY

525 (CONF-770921—P1) **Proceedings of the third biennial conference and workshop on wind energy conversion systems. Volume I.** Kornreich, T.R. (ed.). (JBF Scientific Corp., Wilmington, MA (USA)). May 1978. Contract EX-76-C-01-2521. 509p. Dep. NTIS, PC A22/MF A01.

From 3. biennial wind energy conversion systems conference; Washington, DC, USA (19 Sep 1977).

Separate abstracts are included for 38 papers presented concerning large scale wind systems, small scale wind systems, regional and economic analysis, wind characteristics research, environmental and institutional considerations, and international activities. Four papers were previously input into the energy data base.

526 (CONF-770921—P1, pp 11-31) **Overview of WECS program.** Divone, L. (Dept. of Energy, Washington, DC). May 1978.

From 3. biennial wind energy conversion systems conference; Washington, DC, USA (19 Sep 1977).

In Proceedings of the third biennial conference and workshop on wind energy conversion systems. Vol. I.

Information concerning the present and planned US DOE wind energy program is presented.

AVAILABILITY (CLIMATOLOGY)

REFER ALSO TO CITATION(S) 415

527 (SAND—76-0714) **Wind speed distribution changes with height at selected weather stations.** Reed, J.W. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 67p. Dep. NTIS, PC A04/MF A01.

Ten-year records of hourly wind speed observations at 15 selected weather stations have been smoothed to correct for observer bias. Records were adjusted to a constant, final anemometer height over level airfield terrain at nine stations where the anemometer was moved during the period of record. The anemometer adjustment scheme is described for each location, since the anemometer exposure change and date of change were unique for each location. Finally, wind speed distribution curves and tables of synthesized time series at final anemometer height and at 10 m, 20 m, and 50 m above ground have been prepared. These homogenized series should be useful for various analyses of wind power systems.

ECONOMICS

528 (COO—2621-2(EXEC.SUMM.)) **Operational, cost, and technical study of large windpower systems integrated with an existing electric utility. Final report.** Swanson, R.K.; Smith, R.T.; Johnson, C.C. (Southwest Research Inst., San Antonio, TX (USA)). Apr 1976. Contract EY-76-C-02-2621. 19p. Dep. NTIS, PC A02/MF A01.

The objective of this program was to explore the feasibility of the use of windpower generating systems as supplemental energy sources on existing electric utilities in the time frame of the next two decades. Specifically, the study was centered upon the geographical region served by Southwestern Public Service Company, an investor-owned utility with headquarters in Amarillo, Texas. The region includes most of the Panhandle of Texas, the Panhandle of Oklahoma, parts of eastern New Mexico, and some communities in southwest Kansas. The present capacity of the utility is about 2000 MW. Of prime importance, the region, as distinct from a collection of high wind velocity singularities, is characterized by very high wind power potential.

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

529 (CONF-770921—P1, pp 59-74) **ERDA/NASA 200 kW Mod-0A Wind Turbine Program.** Robbins, W.H.; Sholes, J.E. (Lewis Research Center, Cleveland). May 1978.

From 3. biennial wind energy conversion systems conference; Washington, DC, USA (19 Sep 1977).

In Proceedings of the third biennial conference and workshop on wind energy conversion systems. Vol. I.

An overview of the Mod-OA Program is presented. The Mod-OA Program is directed to the design, manufacture, installation and operation of 200 kW wind turbines in utility power systems to define and resolve problems associated with wind turbines in user systems. A Mod-OA System Description, Development Program and Programmatic Status is included.

530 (CONF-770921—P1, pp 76-85) **Mod-1 wind turbine generator program.** Barchet, R.J. (General Electric Co., Valley Forge, PA). May 1978.

From 3. biennial wind energy conversion systems conference; Washington, DC, USA (19 Sep 1977).

In Proceedings of the third biennial conference and workshop on wind energy conversion systems. Vol. I.

The objective of the Mod-1 Program, as a vital element of the National Wind Energy Program, is quite simple—to develop a large, utility-class WTG which has the potential for generating utility-grade electrical power at costs competitive with alternative energy sources. This implies a megawatt-class machine with an output power quality compatible with typical utility grid voltage/current, ripple, reactance, etc. The development of the Mod-1 WTG has been proceeding on the basis of formal design requirements, some of which will be discussed later. In addition to these "formal" requirements, specific, non-contractual goals have also been formulated. It is this combination of objectives and informal goals which has led to the present Mod-1 WTG system.

531 (CONF-770921—P1, pp 92-102) **Mod-2 wind generator program.** Couch, J.P. (Lewis Research Center, Cleveland). May 1978.

From 3. biennial wind energy conversion systems conference; Washington, DC, USA (19 Sep 1977).

In Proceedings of the third biennial conference and workshop on wind energy conversion systems. Vol. I.

The Mod-2 project will lead to the development of a machine with a minimum 300 foot diameter rotor which is designed for a site having a yearly mean wind speed of 14 mph and is widely useful throughout the United States. The programmatic goal of the Mod-2 project is to produce an electrical generating system that will be cost competitive with conventional fueled powerplants. The cost of electricity target for the one-hundredth Mod-2 wind turbine is in the range of 2 to 4 cent/kW-hr.

532 (PNL—2526) **Wind velocity-change (gust rise) criteria for wind turbine design.** Cliff, W.C.; Fichtl, G.H. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1978. Contract EY-76-C-06-1830. 26p. Dep. NTIS, PC A03/MF A01.

A closed-form equation is derived for root mean square (rms) value of velocity change (gust rise) that occurs over the swept area of wind turbine rotor systems and an equation for rms value of velocity change that occurs at a single point in space. These formulas confirm the intuitive assumption that a large system will encounter a less severe environment than a small system when both are placed at the same location. Assuming a normal probability density function for the velocity differences, an equation is given for calculating the expected number of velocity differences that will occur in 1 hr and will be larger than an arbitrary value. A formula is presented that gives the expected number of velocity differences larger than an arbitrary value that will be encountered during the design life of a wind turbine. In addition, a method for calculating the largest velocity difference expected during the life of a turbine and a formula for estimating the risk of exceeding a given velocity difference during the life of the structure are given. The equations presented are based upon general atmospheric boundary-layer conditions and do not include information regarding events such as tornados, hurricanes, etc.

533 (SAND—77-1164) **Wind turbine data acquisition and analysis system.** Stiefeld, B. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 47p. Dep. NTIS, PC A03/MF A01.

Under Department of Energy (DOE) sponsorship, Sandia Laboratories has implemented a program to develop vertical-axis wind turbine (VAWT) systems. One aspect of this program has been the development of an instrumented test site adjacent to Sandia Laboratories' Technical Area I on Kirtland Air Force Base. Three VAWTs are now in operation on this test site. This paper describes the data acquisition and analyses system developed to meet the needs of the VAWT test site. The system employs a 16-bit work-length

minicomputer as the major element in a stand-alone configuration. A variety of peripheral devices perform the required data acquisition functions and provide for data display and analysis. Included is a disk-based software operating system that supports a mass storage-file system, high-level language, and auxiliary software procedures.

SITE CHARACTERISTICS

534 (BNWL-SA—6457) **Site selection techniques and methodologies for WECS.** Drake, R.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1977. Contract EY-76-C-02-0016. 13p. Dep. NTIS, PC A02/MF A01.

The question of siting a wind energy conversion system, or systems (WECS), represents a balance between economic and technical criteria and the environmental and social values of the user and the local citizens, whether the WECS is for a small farm or a utility serving a multi-state region. The technical siting issues include the meteorological characteristics of the candidate site that contribute to the efficient and safe production of power by wind, the potential weather hazards of the site in question, and the terrain and seismic features of the site. These technical issues are highly related to the size and type of the proposed WECS and the type of storage system (if there is one) required for the installation. A good siting policy is one that optimizes the power output based on the constraints imposed by these various issues.

535 (PNL—2523) **Simulation of the hourly wind speeds for randomly dispersed sites.** Cliff, W.C.; Justus, C.G.; Elderkin, C.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 40p. Dep. NTIS, PC A03/MF A01.

A technique is presented which simulates the hourly wind speeds at any number of dispersed sites within a region. The required input for the simulation is an hourly wind speed record from a single "representative site" and an estimation of the size of the region in which the sites will be located. This technique is not intended for use at any specific location but rather intended to be used for generic mission analysis type studies.

ELECTRIC POWER ENGINEERING

REFER ALSO TO CITATION(S) 874

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 45, 163

536 (COO—4120-2) **Comparative analysis of structural concrete quality assurance practices on three fossil fuel power plant construction projects. Final report.** Willenbrock, J.H.; Thomas, H.R. Jr.; Burati, J.L. Jr. (Pennsylvania State Univ., University Park (USA)). Jun 1978. Contract EY-76-S-02-4120. 117p. Dep. NTIS, PC A06/MF A01.

The basic objective of this research effort was to perform a comparative analysis of the Quality Assurance practices related to the structural concrete phase on three fossil fuel power plant projects which are (or have been) under construction in the United States in the past ten years. This analysis identified the response of each Quality Assurance program to criteria similar to those which apply on nuclear power plant projects. The major emphasis was placed on the construction aspects of the structural concrete phase of each project. The engineering and design aspects were examined whenever they interfaced with the construction aspects. For those aspects of the Quality Assurance system which can be considered managerial in nature (i.e., organizational relationships, types of Quality Assurance programs, corrective action procedures, etc.) an attempt has been made to present the alternative approaches that were identified. For those aspects of the Quality Assurance system which are technical in nature (i.e., the frequency of testing for slump, compressive strength, etc.) an attempt has been made to present a comparative analysis between projects and in relation to the recommended or mandated practices presented in the appropriate industry codes and standards.

537 (FE—2371-24) **Evaluation of a pressurized-fluidized bed combustion (PFBC) combined cycle power plant conceptual design. Quarterly report, October 1—December 31, 1977.** Huber, D.A. (Burns and Roe Industrial Services Corp., Paramus, NJ (USA)). Jan 1978. Contract EX-76-C-01-2371. 24p. Dep. NTIS, PC A02/MF A01.

All activities were concentrated on the development of a design and cost estimate for a nominal 600MWe combined-cycle power plant utilizing pressurized-fluidized beds supplying hot gas to gas turbines followed by a steam-cooled AFB fired boiler. This cycle offers greater power and efficiency than one utilizing a simple waste heat boiler. The net efficiency of the plant was estimated to be 38.1%. The conceptual design of the cycle having four PFB's exhausting to two gas turbines followed by a steam cooled AFB fired boiler was updated. The conceptual design of the PFB's gas turbines and AFB boiler was completed. A preliminary cost estimate of the total project and annual cost of operation were established. Efforts are under way to develop a computer program which not only compares the thermodynamic performance of various cycles, but gives a rapid estimate of the capital and operating costs.

538 (FE—2583-15) **Conceptual design for an atmospheric fluidized-bed direct combustion power generating plant. Phase I. Commercial plant conceptual design. Final progress report, 14 January 1977—31 March 1978.** Norton, R.C. (Stone and Webster Engineering Corp., Boston, MA (USA)). 7 Apr 1978. Contract EF-77-C-01-2583. 12p. Dep. NTIS, PC A02/MF A01.

The conceptual design of a commercial size (560 MW), complete power generating station incorporating an atmospheric fluidized-bed boiler was developed for two parallel cases presenting the boiler designs of two major boiler manufacturers. These were preceded by the presentation of the basis for comparison, which was also a 560 MW unit, that incorporated a conventional pulverizer coal suspension fired boiler with associated facilities including, particularly, a wet limestone flue gas scrubber. This report accounts for the completion progress of the individual tasks that constituted the project. All of the deliverable material items were issued by the end of the contract. They, rather than this report, contain the technical substance of the work.

539 (SVF—49) **Partial condensation of steam: continued investigations.** Tavast, J. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). 13 Jul 1977. 27p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

The apparatus for partial condensation of steam was modified at 5 power plants to allow an analysis of the composition of the partial condensate. Acid impurities were of prime interest. Overheated steam was condensed to approximately 1 percent. The partial condensate was then treated in a cation exchanger and an anion exchanger. The resins were eluted and the eluates were then analyzed for acetic acid, formic acid, chloride, sulfide, ammonia, sodium and potassium. Conventional analyses were also performed of the pH-value, the conductivity before and after an acid cation exchanger, and the ammonia and sodium content of the partial and the total condensate. Due to the existing energy situation, only two of the power plants have been in operation. A certain ammonia concentration corresponded to a certain theoretical pH-value. The difference between the measured and the theoretical pH-values indicates that the partial condensate of Stenungsund has a higher content of acid impurities than the partial condensate of den Haag. The concentration of carbon dioxide of the partial condensate of Stenungsund was less than 100 ppB. At both power plants the pH-value of the partial condensate was some 0.4 pH-units lower than the pH-value of the total condensate. As indicated by earlier measurements, the conductivity of the partial condensate is lower than that of the total condensate. The ammonia concentration of the partial condensate of Stenungsund was 220 ppB according to the analyses of the eluates. The conventional analyses indicated 250 ppB. The ammonia concentration of the partial condensate of den Haag was 90 ppB according to the analysis of the eluate. No sulfide was detected in the eluates. The analyses for sodium and chloride were unreliable. Finally, possible improvements regarding the use of ion exchangers for analytical purposes are suggested.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 441

540 (BNWL-SA—6228) **Dry/wet cooling towers with ammonia as intermediate heat exchange medium.** Allemann, R.T.; Johnson, B.M.; Smith, G.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1977. Contract EY-76-C-06-1830. 16p. (CONF-770516—12). Dep. NTIS, PC A02/MF A01.

From Conference on waste heat management and utilization; Miami Beach, FL, USA (9 May 1977).

Engineering conceptual studies were made of several dry cooling towers for a 500 MW/sub e/ power plant. The most economical method used ammonia as a heat exchange medium. The ammonia condenses the turbine steam in a condenser-reboiler while being evaporated itself. The ammonia vapor is condensed and then recycled from a dry cooling tower. The lowest cost approach utilized a water deluge on the tower during the hottest ambient conditions to effect water savings of 80 percent over an all evaporative system. The total capital, and capitalized operating cost saving for the deluged/ammonia cooling system over a conventional wet/

dry tower is potentially 15 to 30 percent for a typically $30 million tower.

POWER CYCLES

REFER ALSO TO CITATION(S) 34, 873, 878, 879, 880

541 (EPRI-FP—862) **Combustion turbine repowering of reheat steam power plants. Final report.** Foster-Pegg, R.W. (Westinghouse Electric Corp., Philadelphia, PA (USA). Combustion Turbine Systems Div.). Aug 1978. 243p. NTIS.

The purpose of this project was to establish the technical and economic feasibility and the environmental impact of repowering a large, modern reheat fossil steam generator by adding a combustion turbine. Heat rate, added capacity, associated equipment modifications, costs, scheduling, and environmental impacts were evaluated. Several configurations--all retaining the steam generator--were studied. The main emphasis was on a 330-MW oil-fired boiler, but natural gas and coal were also considered. The results of this project indicate that the use of a combustion turbine to supply vitiated combustion air to the steam generator can increase capacity and reduce heat rate. Further, a wide variety of repowering configurations are possible, depending on which of many factors are of main interest. For example, repowered configurations can be identified that maximize heat rate improvement or added capacity, or that minimize down time, heat rejection, capital cost (based on either dollars per kilowatt or absolute dollars), or NO/sub x/ emissions. One typical repowering case yields the following results for the 330-MW oil-fired boiler: an 8240 Btu/kWh heat rate with combustion turbines supplying 23 percent of the plant output. This corresponds to a 32 percent increase in plant capacity and an 8 percent improvement in heat rate. NO/sub x/ emissions are projected to decrease 18 percent in this configuration. Incremental capital costs were placed at $250/kW. Major cost items include dismantling the air preheater, modifying the feedwater systems, and adding a low-temperature economizer and the combustion turbines. Other cases yielding even lower heat rates are covered in the evaluation. The main disadvantage of repowering is the increased use of clean petroleum fuels in the gas turbine. The availability of coal-derived gases and liquids could offset this disadvantage in the future.

COMPONENTS

542 (SVF—51) **Results of laboratory investigations and field test of superheater tubes.** Heurling, K. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). 14 Jul 1977. 50p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

The literature survey, published in SVF-10 regarding the changes of properties in welded joints between creep resistant steels of dissimilar alloy composition, was used for planning laboratory investigations and the field tests of welded joints in superheater-tubes mounted in an experimental boiler. The laboratory investigation showed that fusion boundary failures described in the literature do appear in creep test specimens taken from joints between ferritic creep-resistant steels of different composition when filler metal of high chromium and nickel-base type are used. When welding with filler metals having a composition similar to the lower alloyed steel, no fusion boundary failures do appear. The fusion boundary have in these cases a gradually changing chromium composition, which have limited the carbon diffusion. The test of joints in superheater tubes has showed that the loading conditions have a great importance for the joint efficiency. No cracking could be found in the joints from the superheater tubes although hot tensile test specimens from the same joints fractured in the fusion boundary. A stress analysis of joints between steel with different creep strength ought to be performed to show their reliability under creep deformation.

543 (SVF—52) **Application of different sampling methods and their influence on results of water chemistry analysis at the experimental boiler at Studsvik.** Falk, I.; Dahl, L. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). 16 Jun 1977. 52p. (In Swedish). Dep. NTIS (US Sales Only), PC A04/MF A01.

Studies of the water chemistry have been carried out during the operation of an experimental steam boiler designed for supercritical conditions. The work was aimed at studying different methods of sampling feedwater, boiler water and steam. Another object was to check the water chemistry of the boiler in order to prevent deposits occurring on the water side of the boiler tubes, and to prevent disturbances in turbine operations resulting from dirty steam. Analyses have been performed with the boiler operating at 280, 185 and 165 bar. Analysis results from integral sampling were compared with results from spot sampling. The results show that the analyses carried out after spot sampling often agree with values after integral sampling, but in some cases differ considerably with respect to low concentrations of iron in the boiling water. Analysis results after integral sampling and the mean values after spot sampling are in reasonably good agreement, and show that none of the analyses which were carried out give consistantly lower or higher results because of the sampling method. Of the methods used for sampling feedwater, boiler water and steam the integral sampling method, preceded by repeated blowdown via the sampling line and the cooler, is considered to give the most representative results. The pressure drop across different sections of the boiler has been measured on start-up and after approximately 5,000 h of operation. No significant change in the pressure drop could be measured. This study was carried out during the period 1971 to 1977 in the experimental steam boiler at Studsvik.

544 (SVF—53) **Corrosion induced cracking in wetted parts of boilers.** Eklund, G. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). 25 Aug 1977. 33p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

A literature survey covering the formation, as well as the break-down of magnetite layers on steel in water at high temperatures, is presented. Added to the literature study is a compilation of the results from a nondestructive testing survey of boiler drums in certain high strength materials. It was found that the cracks in the steel are developed at parts with high stress intensity. The damage is initiated while the plant is shut down when oxygen-stimulated corrosion takes place at the fresh metal surfaces revealed at the bottom of the cracks in the magnetite layer. When the plant is started up the pressure increases and cracks in the metal develop.

545 (SVF—54) **Boiler tube deposits at bark combustion. Additional measurements and investigation of thermodynamic equilibria.** Simmons, T. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). 15 Sep 1977. 31p. (In Swedish). Dep. NTIS (US Sales Only), PC A03/MF A01.

As a continuation of the earlier research in the field of boiler tube deposits, caused by combined firing of oil and bark, a practical test has been carried out on two boilers, where magnesium based additives have been used alternatingly with periods without such additives. It was found that they have a positive effect on the properties of the deposits in the boilers, even if a true evaluation of the two tested additives, as compared with one another, is uncertain. The earlier discussion about the background of the effect of magnesium is supplemented by a study made by Svenska Traforskningsinstitutet.

546 **Gas turbines geared to success.** Collins, A.O. *Energy Dig. (London)*; 7: No. 2, 14-17(Apr 1978).

This article describes the development and applications of Ruston gas turbines and Allen epicyclic gearing. Of particular interest from the point of view of energy conservation are two applications. One of the best known installations in the U.K. is the Greater London Council's sewage treatment plant at Beckton. Methane gas generated from the sewage process at Beckton fuels ten gas turbines which, in addition to providing power for electrical and mechanical drives, help to produce hot water for sludge digestion and for the works by passing the exhaust gases through water heaters. A notable Ruston TA gas turbine installation in the U.K. operating on total-energy principles is at the John Player and Sons tobacco factory, Nottingham. At the John Player factory are twelve Ruston engines driving 1,152kW alternators. These units supply all electricity for plant operation and for air conditioning (the factory is not connected to the public electricity supply system) and process steam.

547 **High temperature water cooled gas turbine in combined cycle with integrated low BTU gasification.** Alff, R.K.; Manning, G.K.; Sheldon, R.C. (GE, Adv Proj Eng). *Combustion;* **49**: No. 9, 27-34(Mar 1978).

In June of 1976, the General Electric Gas Turbine Division (GTD) initiated work on Phase 1 of the High Temperature Turbine Technology Program (HTTTP) funded by the Fossil Energy Division of ERDA. The objective of this three-phase program is to advance, in a six-year period, the technology of a high temperature (multi-stage) power turbine subsystem to a Technology Readiness condition. General Electric's prime design approach in pursuing this objective has been the water cooled gas turbine. This article presents results of General Electric's approach to Phase 1. Turbine subsystem design studies are reviewed. Although alternate back-up turbine designs (air and steam cooling) and three overall plant design descriptions (for coal, oil and low-Btu gas fuels) were developed, principal emphasis was directed at the prime water cooled turbine concept and its operating features in the combined cycle plant with integrated fixed bed gasification.

548 (NP-tr—2020) **Water regime for supercritical units. Chapter 9. Chemical monitoring of the water regime of 300 MW units.** Akolzin, P.A. 1977. Translated from Vodny rezhim paroturbinnikh blokov sverkhriticheskikh parametrov, Energiya, Moscow, 1972. 16p. British Library Lending Div., Yorkshire, Eng.

The equipment and procedures required for monitoring chemical conditions in water used in thermal power plants are discussed. This water includes feed water, water and steam in the

energy conversion equipment, and waste waters. The reliability, operation, and cost of sampling equipment and completely automated chemical monitoring systems are described. (LCL)

549 (NP-tr—2026) **Detection of overheating in hydrogen-cooled turbo-generators.** Metzger, G.; Fournie, R. Translated from *Rev. Gen. Electr.;* **85**: No. 4, 271-276(Apr 1976). 20p. British Library Lending Div., Yorkshire, Eng.

The presence of gaseous compounds in the cooling circuit of a turbogenerator may indicate the occurrence of local overheating. A detection method is described that consists of sampling and concentrating the impurities present in the hydrogen coolant which can be analyzed by gas chromatography. A few applications are described which were the subject of several studies between 1968 and 1974. When studying the degradation of the materials used in the construction of the machines, the results obtained could be interpreted from samples taken at a thermal power station.

550 (NP-tr—2025) **Steam power plant: corrosion prevention during shut-down periods.** Steger, H. Translated from *Maschinenschaden;* **49**: No. 1, 23-27(Jan 1976). 14p. British Library Lending Div., Yorkshire, Eng.

A method is described for preventing corrosion damage in steam turbogenerators which are shutdown for long or short periods and which must be available for immediate operation. Steel corrosion mechanisms are discussed. Corrosion is prevented by keeping the relative humidity of air in the turbine below 50 percent and preferably below 35 percent using the dry air method. Air driers for use with this method are described. The dry air method can also be used to prevent corrosion damage in other power plant components such as boilers and superheaters. It is concluded that it is relatively inexpensive to use reliable and virtually maintenance-free air demoisturizers operating on the adsorption principle to prevent corrosion damage in power plant turbines and to avoid the high costs for stoppages and repairs which would result from such damage. (LCL)

551 (NP-tr—2033) **Centering effect in labyrinth type seals and its effect on low frequency vibration of turbomachines.** Orlik, V.G. Translated from *Energomashinostroenie;* **10**: 25-29(1975). 18p. British Library Lending Div., Yorkshire, Eng.

The conditions which cause low-frequency vibrations in turbomachinery with labyrinth seals are examined theoretically. Flow in the seal with and without misalignment of the rotor and stator axes is considered. The effect of different seal configurations on centering of the rotor shaft is discussed, and compared with experimental data. It was found that one of the effective measures for eliminating low-frequency vibration in a turbine unit is to replace flow-through seals with stepped-type seals. (LCL)

ECONOMICS

552 (ORNL/SUB—7257/7) **Feasibility study: comparison of coal- and nuclear-fueled alternatives for process steam and by product electrical power generation for the E.I. Du Pont de Nemours and Company, Incorporated Plant Site, Victoria, Texas.** (Power Systems Engineering, Inc., Houston, TX (USA)). Jul 1978. Contract W-7405-ENG-26. 156p. Dep. NTIS, MF A01.

Portions of document are illegible.

The purpose of the study was to evaluate the technical and economic feasibility of a small, (365 MWt) nuclear reactor for supplying process steam and electricity as a replacement for energy sources using increasingly scarce natural gas or oil. The Du Pont Chemical Plant Site at Victoria, Texas, was chosen as representative of industrial installations that require sizeable amounts of process steam and electricity. For comparison purposes conventional coal-fired boilers were also evaluated. It was determined that both nuclear- and coal-based process energy supply systems are technically feasible. For the specific steam/electricity demands at the reference site, the coal-fired plant proved to be economically more attractive than the nuclear units. For an application requiring a base-loaded supply of saturated steam, utilizing full reactor capacity, the nuclear option appears competitive for coal costing $37/ton in 1978 dollars.

553 (ORNL/SUB—7257/8) **Feasibility study: comparison of coal- and nuclear-fueled alternatives for process steam and by product electrical power generation for the PPG Industries, Incorporated Plant Site, Lake Charles, Louisiana.** (Power Systems Engineering, Inc., Houston, TX (USA)). Jul 1978. Contract W-7405-ENG-26. 140p. Dep. NTIS, MF A01.

Portions of document are illegible.

The purpose of the study was to evaluate the technical and economic feasibility of a small, (365 MWt) nuclear reactor for supplying process steam and electricity as a replacement for energy sources using increasingly scarce natural gas or oil. The PPG Industries, Incorporated Plant Site at Lake Charles, Louisiana, was chosen as representative of industrial installations that require sizeable amounts of process steam and electricity. For comparison purposes conventional coal-fired boilers were also evaluated. It was determined that both nuclear- and coal-based process energy supply systems are technically feasible. For the specific steam/electricity demands at the reference site, the coal-fired plant proved to be economically more attractive than the nuclear units. For an application requiring a base-loaded supply of saturated steam, utilizing full reactor capacity, the nuclear option appears competitive for coal costing $40/ton in 1978 dollars.

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 836

FUELS

REFER ALSO TO CITATION(S) 547

554 (TID—28408) **Methane utilization from coalbeds for power generation. Quarterly technical progress report, December 1, 1977—April 1, 1978.** Sturgill, C.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). 1978. Contract EY-77-C-21-8098. 13p. Dep. NTIS, PC A03/MF A01.

The objective of this program is to demonstrate the economic utilization of mine gas (a diluted mixture of methane and air) as a fuel for gas turbine/electrical generator conversion of the mine gas to electrical energy. The work scope provides for the installation and operation of a system based on existing components usage, and is divided into three phases. The first two phases are required to complete all design, procure parts and assemble the system at the site. The remaining phase is devoted to operation of the system at the site, measuring performance, and documenting the overall program in a final report. Information is included on use of gob degasification boreholes as a fuel source, modification of a Saturn engine for use as the demonstration gas turbine, safety review, economic and environmental impact analyses, design of electric power interface, and evaluation of the fuel reservoir. (LCL(

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 125, 1312, 1317, 1564, 1575

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 6, 117, 120

555 (EPA—600/7-77-073b) **Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.). Jul 1977. 306p. (CONF-770885—P2). NTIS.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

Ten papers presented at the conference are included in this volume. A separate abstract was prepared for each paper. (LCL)

556 (EPA—600/7-77-073b, pp 3-40) **Field testing: application of combustion modification to power generating combustion sources.** Crawford, A.R.; Manny, E.H.; Bartok, W. (Exxon Research and Engineering Co., Linden, NJ). Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

A field study program was conducted to assess the applicability of combustion modification techniques to the control of NO/sub x/ and other pollutant emissions from power generating combustion sources. This work is part of a continuing series of field test programs performed by ER and E on utility boilers and other power generating combustion sources. The goal of this research is to determine whether known modifications can be applied to the combustion process for NO/sub x/ control, without causing deleterious side effects. The studies reported include field tests on utility boilers and gas turbines employed for power generation. Comprehensive, statistically designed test programs were conducted to evaluate the effect of combustion modifications on NO/sub x/ and other gaseous emissions. In addition, particulate mass and size distribution and boiler efficiency were determined under baseline and low NO/sub x/ operating conditions. The most extensively studied combustion modification for utility boiler applications was staged firing at low excess air. This approach can achieve reductions in NO/sub x/ emissions up to about 50% based on the results of short term tests. With the focus of the program on NO/sub x/ emission control for coal-fired utility boilers, special attention was paid to the determination of potentially adverse side effects—increased combustible emis-

sions, unwanted changes in particulate mass loading and size distribution, reduced boiler efficiency, increased waterwall slagging and external corrosion, and flame problems. Short term tests indicate that staged combustion may be applied to coal fired utility boilers. The extent of waterwall corrosion and slagging could not be determined unequivocally based on the results of 300-hour corrosion probing runs under low NO/sub x/ and baseline operating conditions.

557 (EPA—600/7-77-073b, pp 41-65) **Analysis of NO/sub x/ control in stationary sources.** Dykema, O.W. (Aerospace Corp., El Segundo, CA). Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

The subject program is a three-year effort to analyze NO/sub x/ control in utility boilers by combustion modifications. Previous studies concluded that there appeared to be no inherent limit to reduction in NO/sub x/ by combustion modification in utility boilers except those that may result from other undesirable side effects. Among those discussed were: (a) excessive water-wall erosion/corrosion, (b) excessive losses in plant efficiency, and (c) combustion instability. The first of these is being investigated experimentally by several agencies. The latter two are the subject of this paper. In general, the analysis of a large sample of data from tests on natural gas-and oil-fired utility boilers showed no significant effects on plant efficiency due to staged combustion (or burners-out-of-service) or the use of NO/sub x/ ports. The data available to this study were not adequate to evaluate this conclusion with respect to coal-fired boilers or for any other combustion modification technique (specifically, water injection or combustion air temperature control). The analysis of combustion instability in utility boilers, however, did show that operating the burners fuel-rich (as in staged combustion) does tend to create more unstable combustion, specifically in air-side feed system-coupled modes of combustion instability. The fuel-rich burner operating conditions in staged combustion increase the dynamic response, or gain, of combustion in the furnace and the air flow rate through the burner. A method of analysis was developed which shows that, with proper design, these modes can be stabilized even with very fuel-rich burner operation.

558 (EPA—600/7-77-073b, pp 67-102) **Overfire air technology for tangentially fired utility boilers burning Western U.S. coal.** Selker, A.P.; Burrington, R.L. (Combustion Engineering, Inc., Windsor, CT). Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

Results are presented of a program designed to study methods of reducing NO/sub x/ formation in tangentially fired steam generating units firing western U.S. coal types. High (western bituminous) and low (sub-bituminous) rank coals were studied.

559 (EPA—600/7-77-073b, pp 103-121) **EPRI program on NO/sub x/ control using combustion modification techniques.** Yeager, K.E.; Teixeira, D.P. (Electric Power Research Inst., Palo Alto, CA). Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

The utility industry, through the Electric Power Research Institute (EPRI), is actively pursuing a significant NO/sub x/ control technology program to assure that the NO/sub x/ emissions do not become a factor limiting the construction or operation of fossil fueled power plants. The program is directed primarily at understanding the reliability, performance and cost implications of alternative control technologies. This paper specifically reviews the status and results to date from three major combustion control projects in the EPRI program: (1) low-NO/sub x/ coal combustion development, (2) selective non-catalytic ammonia reduction of NO/sub x/, (3) low-NO/sub x/ turbine combustor development. The configuration and design parameters of a two-stage combustion system for coal are described. The selective, non-catalytic ammonia reduction of NO/sub x/ is directed at verifying the behavior of ammonia with NO/sub x/ in the presence of coal fly ash. The laboratory-scale (3 x 10/sup 6x/ Btu/hr.) examination of four bituminous and subbituminous coals is described. The objective of the low-NO/sub x/ turbine combustor development program is to evaluate the potential for a gas turbine combustor capable of meeting 75 ppM NO/sub x/ at 15% O_2 without water injection. The performance of dry control configurations incorporating premixing coincidental with prevaporization is described.

560 (EPA—600/7-77-073b, pp 123-141) **Cyclone boilers: their NO/sub x/ emissions and population.** Ctvrtnicek, T.E. (Monsanto Research Corp., Dayton, OH); Rusek, S.J. Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

There are 149 boiler units in the United States that are fired by a total of 736 cyclone furnaces. All of the cyclone furnaces are located in the East and Midwest. Three states, Illinois, Missouri, and Indiana, account for nearly half of the total-fired steaming capacity and one-third of the boilers. Since cyclonic combustion takes place at high combustion temperatures, cyclone furnaces firing utility and industrial boilers are high NO/sub x/ emitters. Based on available data, their measured full-load emissions were 576 ng/J to 718 ng/J for bituminous coal firing, 546 ng/J for subbituminous coal firing, 291 ng/J to 355 ng/J for lignite firing, 217 ng/J to 318 ng/J for residual oil firing, and 208 ng/J to 325 ng/J for natural gas firing. It is estimated that 0.76 x 10^6 metric tons of NO/sub x/ were emitted from all cyclone coal-fired utility boilers in 1973. This represents from 19% to 22% of the NO/sub x/ produced by all coal-fired utility boilers in the U.S. Correspondingly, between 10% and 13% of coal consumed by all coal-fired utilities was used by cyclone fired units. Similar estimates for industrial boilers could not be obtained due to insufficient data. Several combustion modification techniques have been applied to cyclone boilers/furnaces in an attempt to lower their NO/sub x/ emissions. These include boiler load reduction, low excess air firing, two-stage firing, and switching fuels. Even though significant reductions in NO/sub x/ were achieved, none of the techniques was shown to reduce NO/sub x/ emissions to the level meeting the EPA's New Source Performance Standards for NO/sub x/.

561 (EPA—600/7-77-073b, pp 145-161) **Noncatalytic reduction of NO/sub x/ with NH_3.** Bartok, W. (Exxon Research and Engineering Co., Linden, NJ). Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

Exxon Research and Engineering Company has developed a post-flame injection process for the reduction of NO/sub x/ to nitrogen with ammonia (U.S. Patent No. 3,900,554). The feasibility of this technique has been demonstrated by ER and E and Exxon's Japanese affiliate for an oil fired boiler. The technology has been commercialized for oil and gas fired boilers. The ammonia injection technology (Thermal DeNO/sub x/ process) is viewed as potentially a useful supplement to available combustion modification techniques for attaining low NO/sub x/ levels for installations that require such degree of control. An analysis of utility boiler types is made to determine what coal fired boiler types by design, size, or manufacturer are most likely to be amenable to the Thermal DeNO/sub x/ process. Budget type cost analysis for the application of the Thermal DeNO/sub x/ process is made as a function of utility boiler size, fuel, appropriate boiler characteristics and degree of NO/sub x/ reduction. The costs of the Thermal DeNO/sub x/ process are compared with those for extreme combustion modifications that would be required to achieve very low NO/sub x/ levels.

562 (EPA—600/7-77-073b, pp 163-208) **Western coal in industrial boilers.** Maloney, K.L. (KVB, Inc., Tustin, CA); Langsjoen, P.L. Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

Ten small and intermediate-sized [4.5 Mg/hr to 113 Mg/hr (10,000 lb/hr steam to 250,000 lb/hr steam)] coal-fired boilers in the upper Midwest have each been tested on both a bituminous eastern coal and a subbituminous western coal. The purpose of this study was to determine the feasibility of substituting western subbituminous coal for eastern bituminous coal as a means of reducing the SO/sub x/ emissions from this class of boiler and to demonstrate the feasibility of greatly expanded western coal utilization as a means of reducing the use of oil and gas. The scope of this study was such that the representative boiler types were tested on both eastern and western coal for a period of time sufficient to completely characterize their individual emission and operational characteristics.

563 (EPA—600/7-77-073b, pp 211-255) **Survey of sulfate, nitrate, and acid aerosol emissions and their control.** Kircher, J.F. (Battelle Columbus Labs., OH); Levy, A.; Wendt, J.O.L. Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

The objective of this analytical study was to evaluate the effects of fuel and combustion modifications on the formation of primary acid aerosols and their significance as combustion generated pollutants from large stationary sources. The term acid aerosol is used here in its broadest sense to include all sulfates, nitrates,

chlorides, and fluorides in all their forms. Primary acid aerosols are those aerosols which are emitted directly from a source or formed, primarily by condensation reactants, in the immediate vicinity (0.5 mi); secondary aerosols, formed by reactions downstream in the plume, are not considered. Available field data were collected and interpreted in view of current knowledge of mechanisms of formation of potential acid aerosols and their precursors. Sulfates, nitrates, chlorides, and fluorides were considered initially; hoever, based on the data available, only sulfates appear to make a significant contribution to primary acid aerosols. Thermodynamic calculations bring out significant differences to be expected in the emission of sulfates of minor constituents from coals and oils. The various combustion modifications for NO/sub x/ control, including low excess air, staged combustion, flue gas recirculation, and reburning, are expected to have little effect on emissions of primary acid aerosols. The exception to this conclusion may be firing with low excess air which has the potential to abate both NO/sub x/ and acid aerosol emissions. Combustion modifications and fuel changes may lead to an increased formation of small particles which could increase the formation of acid aerosols through various heterogeneous reactions. Most of the effects are rather speculative due to the meager data available. An important technological gap brought out in this study is the lack of information on the specific sulfates being emitted from stationary sources today.

564 (EPA—600/7-77-073b, pp 257-278) **Inventory of atmospheric emissions from stationary point sources.** Kemp, V.E.; Dykema, O.W. (Aerospace Corp., El Segundo, CA). Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

The first and second years of a stationary source combustion-related atmospheric emissions inventory being conducted by The Aerospace Corporation for the EPA are described. This is a 3-year study aimed at assisting in the establishment of priorities for detailed studies of techniques for the control of combustion-related emissions from stationary sources. The inventory includes emissions of oxides of nitrogen, unburned hydrocarbons, carbon monoxide, and particulate matter, not only from recognized major stationary combustion sources, but also from other stationary source categories in which combustion plays a secondary role. During the first year of the study, emissions were established for 1975 and estimated for 1980 from boilers, internal combustion engines, chemical manufacturing, and petroleum refining. During the second year, emissions were calculated for 1976 and 1981 for primary metals and hydrocarbon evaporation, as well as for the four industries studied the first year. This paper identifies approximately 68% of particulate matter and 93 to 97% of nitrogen oxide, hydrocarbon, and carbon monoxide emissions from stationary point sources. The third year of the study will raise the inventoried emissions to greater than 90% for all four pollutants. The emission rates were calculated based on process usage rates, emission factors, and time rate of change of these variables for the respective categories of stationary source of emissions. In addition to estimating the annual nationwide emission rates of the four referenced pollutants, the uncertainty of those rates was established. Statistical engineering estimates, current and potential legislative environmental controls, and several independent sources of data were considered in calculating these uncertainties.

565 (EPA—600/7-77-073b, pp 279-299) **Emissions assessment of conventional combustion systems.** Matthews, B.J. (TRW, Inc., Redondo Beach, CA). Jul 1977.

From 2. symposium on stationary source combustion; New Orleans, LA, USA (29 Aug 1977).

In Proceedings of the second stationary source combustion symposium. Volume II. Utility and large industrial boilers.

The Industrial Environmental Research Laboratory (IERL) of the Environmental Protection Agency, in association with TRW Environmental Engineering Division, is conducting an extensive multimedia assessment of emissions from conventional stationary combustion systems. The program's purpose is the assessment of air, water, and solid waste emissions from approximately 51 categories of residential, commercial, industrial and utility combustion sources, burning gas, oil, coal and refuse. This involves the collection of existing test data plus an extensive sampling and analysis program. The forty-four (44) month program is scheduled for completion in the spring of 1980. Reports on specific types of combustion sources will be issued periodically starting in late 1977.

566 **Electrostatic precipitation theory: a review.** Oglesby, S. Jr.; Gooch, J.P. (Southern Research Inst., Birmingham, AL). *Chem. Eng. (London);* No. 333, 473-476(Jun 1978).

The process of electrostatic precipitation of industrial dusts involves a number of interrelated steps, which include the generation of an electrical corona, particle charging, collection and removal. The development of a mathematical model is reviewed that calculates the magnitude of the charge, the electric field, and the collection of efficiency based on theoretical considerations, and the departures from theoretical behavior due to nonidealities of the precipitation process. The predicted performance of precipitators is compared with experimental results from pilot and full-sized plants.

567 **Fabric filtration for coal-fired boilers.** Dennis, R. (GCA Corp., Bedford, MA). *Chem. Eng. (London);* No. 333, 480-484(Jun 1978).

The capabilities of fabric filters are examined in the light of stricter controls for coal fly ash emissions. Limited but successful field use of high temperature, glass fabrics plus extensive laboratory testing now provide the guidance to design and operate effectively fy ash control systems for industrial and utility boilers. Fabric service life, pressure loss, effect of filtration velocity on efficiency, cleaning behavior and the availability of new predictive filtration models are discussed.

568 **Field evaluation of fine particle scrubbers.** Calvert, S. (Air Pollution Tech. Inc., San Diego, CA). *Chem. Eng. (London);* No. 333, 485-490(Jun 1978).

The performance of thirteen industrial scrubber systems have been determined experimentally. The performances are reported in terms of grade penetration curve and cut/power relation. The measured performances of these scrubbers are compared with predictions of design equations. In cases where design equations are not available, they are developed from basic theories. Except for the design equation for the mobile bed scrubber, design equations for other types of scrubbers tested give reasonable performance predictions. The scrubber performance, expressed as the cut diameter versus power relationship developed by Calvert has been verified and extended with the performance data.

569 **Control of particulate emissions from thermal power stations using electrostatic precipitators.** Muthukrishnan, K.V. *Indian J. Environ. Health;* **16**: No. 3, 267-275(Jul 1974).

The paper presents fundamentals and working of electrostatic precipitators as a high efficiency dust collection system and states them as the most favored choice for applications in boiler operation in thermal power plants due to their most efficient and economical performance.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 1564, 1572, 1573

AC SYSTEMS, EHV AND UHV

570 (EPRI-EL—810) **Development of distribution and subtransmission SF_6 circuit breaker and hybrid transmission interrupter. Final report.** Votta, G.A. (I-T-E Imperial Corp., Colmar, PA (USA). Research and Development Div.). Jun 1978. 85p. Dep. NTIS, PC A05/MF A01.

This project covered the development of a new generation of SF_6 arc spinner interrupters, a 15-kV circuit breaker (distribution) using this interrupter, and investigated the feasibility of a high voltage (transmission) hybrid interrupter using the arc-spinner and a vacuum interrupter in series. The arc spinner interrupter concept uses a self-generated magnetic field to drive an arc, on a circular path in an atmosphere of SF_6 gas, to achieve interruption. Test models of the arc spinner interrupter were built and tested to determine the component requirements and arrangements necessary for the desired performance. A single-phase laboratory model of this interrupter was successfully tested up through 25 kA at 13.5 kV. Interruption of 40 kA at 13.5 kV was demonstrated; however, satisfactory performance was not obtained at significant current levels during this program when tested at higher voltages. A full-scale model of a three-phase outdoor distribution power circuit breaker rated 18 kA at 15.5 kV was built and successfully tested to standards. The hybrid interrupter concept (transmission) uses an arc spinner and a vacuum interrupter in series. The vacuum interrupter handles the high initial rate of rise of recovery voltage associated with short line faults, and the arc spinner interrupter handles the high peak transient recovery voltage. The hybrid interrupter demonstrated an ability to handle the initial high rate of rise recovery voltage but encountered dielectric failures at relatively low current levels. This feasibility investigation was limited by the unavailability of a suitable rating of vacuum interrupters and by limitations inherent to an early model arc spinner interrupter for the tests. The investigation of the hybrid was discontinued until further development of a higher voltage arc spinner interrupter could be accomplished.

571 (EPRI-EL—823) **Three-phase UHV ac transmission research. Final report.** Comber, M.G.; Schneider, H.M.; Nigbor, R.J. (General Electric Co., Pittsfield, MA (USA)). Jul 1978. 314p. Dep. NTIS, PC A14/MF A01.

Results are presented of the work performed at EPRI's Project UHV from January 1974 to December 1976. During this period, a three-phase ac test line with line voltages up to 1500 kV was constructed and operated. The feasibility of UHV transmission has been demonstrated and the most important problems impacting on cost and performance have been identified. Design data on the corona performance of conductor and line configurations and on the dielectric strength of the external insulation of UHV transmission systems have been provided. The results obtained confirm and extend the data contained in the Transmission Line Reference Book—345 kV and Above, published by EPRI in 1975.

572 (NP-tr—2016) **Up-to-date optimisation model for electrical distribution systems.** Cwienk, G. Translated from *Elektrotech. Z., A;* **97**: No. 4, 218-224(Apr 1976). 18p. British Library Lending Div., Yorkshire, Eng.

The optimization of electricity distribution networks was investigated and is described with the aid of four practically-based approaches to the problem using the method of mathematical model simulation. Practical parameters of importance to supply undertakings are derived relating to the following problems: the optimization of existing older networks as the load increases (particularly in the event of the connection of storage heating systems); the optimum time for replacing existing transformer units as the load increases; the optimum choice of rated capacity and type of distribution transformers for a given set of demand conditions when new investment is involved; and the selection of the optimum supply arrangements with varying numbers of substations in new, larger supply networks supplying an all-electric area. Reasoning is advanced to show why absolute optimization of networks cannot be derived, and at the same time proof is given of the reliability of partial optimization based on rated capacity or maximum loading, dependent on the problem involved.

573 (NP-tr—2038) **Switching arcs in power systems.** Pietsch, G.; Rijanto, H.; Thiel, H.G. Translated from *Elektrotech. Z., A;* **96**: No. 5, 222-226(1975). 15p. British Library Lending Div., Yorkshire, Eng.

In order to calculate breaking performance in high power circuit breakers, an equation was derived which describes the switching arc interacting with the electrical system. This equation contains two characteristic quantities which can be evaluated by experiments. In order to calculate these quantities, a mathematical arc model has been developed which is based on experimental knowledge of switching arc properties. In the case of short line fault interruption, this method has proved very useful for a detailed description of breaking processes.

574 (NP-tr—2030) **Assessing the reliability of networks of insulated cables from statistical breakdown tests on samples. Extrapolation limits and possible statistical anomalies.** Oudin, J.M. Translated from *Rev. Gen. Electr.;* **80**: No. 4, 330-334(Apr 1971). 14p. British Library Lending Div., Yorkshire, Eng.

With a view to assessing the reliability of networks of insulated cables, the value of the hypotheses of the statistical theory of dielectric breakdown is reconsidered, and the precautions to be taken as regards extrapolation of breakdown tests at high voltage gradients and of the life curve towards low voltage gradients (service gradient) are explained.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

575 (LA—7356-PR) **LASL Nb_3Ge conductor development. Progress report, 1 January—31 March 1978.** Maley, M.P. (comp.). (Los Alamos Scientific Lab., NM (USA)). Jun 1978. Contract W-7405-ENG-36. 25p. Dep. NTIS, PC A02/MF A01.

The tenth quarterly progress report of the Los Alamos Scientific Laboratory program to develop Nb_3Ge as a superconductor with potential applications to superconducting power transmission lines covers the period January 1 to March 31, 1978. The production of long lengths of Nb_3Ge-clad tapes has now been extended to 20.0-m lengths without observable degradation of uniformity or superconducting properties. Sections taken from the tapes exhibit an average critical current density of 2.4 x 10^6 A/cm^2 at 14.0°K. An investigation of the influence of deposition temperature T/sub D/ upon superconducting properties of the long tapes has been completed. We found that T*/sub c/ rises monotonically with T/sub D/ to a new maximum of 20.2°K at T/sub D/ = 955°C. High magnetic fields measurements were extended to 18.6 T at the Francis Bitter National Magnet Laboratory. These measurements allowed analysis of flux pinning to be made. The pinning force density of our samples is found to obey the scaling law proposed by Kramer. Values of H/sub c2/ as high as 33.0 T were measured for our bulk samples.

576 (NP-tr—2024) **Calculating the magnetizing current inrush in three-phase power transformers allowing for the fluxes in the space around the limbs.** Novash, V.I.; Abramenko, V.M. Translated from *Izv. Vyssh. Uchebn. Zaved., Energ.;* **16**: No. 1, 25-30(Jan 1973). 9p. British Library Lending Div., Yorkshire, Eng.

A mathematical description is given of a two-winding 3-phase 3-limb transformer. This model takes into account the magnetic fluxes around the limbs. These equations were used to make computer calculations of the magnetizing current inrush(MCi)in the transformer. A large number of calculations of the mci of fluxes in the space around a winding, also of their derivatives with the transformer switched on and under steady no-load conditions, for various values of the supply voltage, were made using the programmes which were worked out. Quantitatively the calculation results agree well with experimental data obtained with the same transformer. The results of calculations for powerful power transformers agree qualitatively with oscillograms which have been published and with the results of calculating from other accurate data. The results confirmed that allowing for losses has no appreciable effect on the magnitude and nature of the mci, while the losses have an extremely great effect on the shape of the curve for the steady no-load current. Allowing for the fluxes Δ PHI/sub A/ and Δ PHI/sub C/ results in the maximum values of the mci when a transformer is cut in being reduced to from 20 to 30 percent, and the maximum mci in the outer and central phases being equalized. As experimental data are accumulated, the algorithm described can be used to take account of nonlinearity of the leakage inductances and reluctances in the space around the limbs. (LCL)

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 942

577 **Operational planning studies for integration of nuclear power plants.** Mehta, D.B. (TATA CONSULTING ENGINEERS, BOMBAY (INDIA)); NARASIMHAN, R.; RAO, G.S. (TATA ELECTRIC COMPANIES, BOMBAY (INDIA)). pp 132-142 of Symposium on operating experience of nuclear reactors and power plants. Bombay; Department of Atomic Energy (1977).

From Symposium on operating experience of nuclear reactors and power plants; Bombay, India (7 Feb 1977).

To integrate a power plant successfully into an existing power system maintaining the same level of safety, reliability and economy, an understanding of the operational characteristics of power systems is essential. This is more so when the power plant is a nuclear one. Some of the important characteristics of a power system that influence the design and operation of a power plant are : (i) rate of change of system load, (ii) loading pattern for hydro and thermal units, (iii) probability of failures of power system equipment and (iv) voltage and frequency fluctuations.

578 **Operating experience with nuclear power stations in member states in 1975.** Vienna; IAEA (1976). 289p.

Annual operating information for 145 nuclear power stations in Member States for the year 1975 is given.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 696, 701, 705, 755, 757, 758, 762, 765, 766, 767, 770, 776, 781, 784, 786, 789, 798

579 **Investigation and examination on the cracking of pipings in boiling water reactors.** *Genshiryoku Iinkai Geppo;* **21**: No. 12, 21-26(Mar 1977). (In Japanese).

This is the report made by the Reactor Safety Technology Expert Committee to the Atomic Energy Commission regarding the investigation and examination on stress corrosion cracking which seems to be the cause of the cracking of pipings in boiling water reactors, the measures to reduce it, and the subjects of research hereafter. Recently, the stress corrosion cracking of primary coolant pipings has been often observed, and this phenomenon occurred in the pressure boundary of primary coolant, consequently it is possible to be linked to the troubles of large scale. The Reactor Material Subcommittee was established on May 14, 1975, and investigated the cracking phenomena in the recirculating system and core spray system of BWRs in Japan and foreign countries. The recent cases have been concentrated to the heat-affected part due to welding of 304 type austenitic stainless steel pipings of from 4 in to 10 in diameter for BWRs. They are the stress corrosion cracking at grain boundaries occurred under the loaded condition and in the environment of high temperature, high pressure water. The cracking of this kind was never experienced in PWRs. The results of the technical

examination, the consideration of the mechanism of stress corrosion cracking, and the countermeasures are described.

580 (KFK-EXT—15/77-2) **Physical properties for heat conduction calculations for LWR fuel rods and their simulators.** Wagner, K.; VOLLMER, T. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Reaktorbetrieb und Technik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit). Aug 1977. 79p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The physical properties, which were used in an heat conduction program for fuel rods and fuel rod simulators in the Nuclear Safety Project (PNS 4236 and PNS 4237.1 and .2), were selected from the secondary literature. As it is useful for some computer programs, tabulated properties data were approximated as a function of temperature in the temperature-range needed.

581 (NUREG/CR—0253) **Postirradiation examination data report for Gap Conductance Test series, Test GC 2-3.** Cook, B.A. (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1978. Contract EY-76-C-07-1570. 125p. (TREE—1231). Dep. NTIS, PC A06/MF A01.

Data from the postirradiation examination of four boiling water reactor (BWR) type, zircaloy-clad, UO_2-fueled rods tested in a simulated BWR environment in the Power Burst Facility test loop are presented. These rods were employed in Gap Conductance Test GC 2-3 which was performed to obtain experimental data from which fuel rod gap conductance and fuel effective thermal conductivity values could be determined. The postirradiation examination results will aid in interpreting the experimental data obtained during Test GC 2-3 and in evaluating the effect of design parameter variations on the fuel rod thermal response, interpreted gap conductances, and thermal conductivities. Fuel rod fill gas composition and pressure are discussed. Measurements of fuel pellet-to-cladding gap and fuel crack areas are presented. The fuel structures are analyzed. Test rod thermocouples and axial power profiles are examined to aid in subsequent evaluation of instrument performance and test rod thermal response.

582 (ORNL/SUB—4380-5) **Assessment of utilization of thorium in BWRs.** Williamson, H.E. (General Electric Co., San Jose, CA (USA)). Jan 1978. Contract W-7405-ENG-26. 166p. Dep. NTIS, PC A08/MF A01.

Performance characteristics and trends which could affect the incentives for and feasibility of use of thorium-based fuels in BWRs were investigated using preliminary scoping techniques. Benchmark comparisons with selected critical experiments and Monte Carlo calculations were made for simple geometries. Several fuel compositions, including uranium fissile isotopes diluted ("denatured") with U-238 to reduce fissile enrichment below that suitable for weapon purposes, were evaluated. Emphasis was focused on design approaches which utilize unique BWR characteristics such as increased coolant boiling and nonuniform lattices. Thorium-based fuel material utilization efficiency in the BWR, without reprocessing and uranium recycle, shows no improvement in resource utilization relative to the UO_2 stowaway recycle. If plutonium recycle were restricted, then a major resource utilization incentive would exist for thorium use in LWRs with denatured uranium recycle and plutonium use in secured energy centers. The characteristics of hypothesized symbiotic systems involving secured plutonium burning sites are illustrated. However, the significant quantity of plutonium produced when "denatured" uranium is used raises question as to the nonproliferation effectiveness of the system. A distinctive incentive for thorium in the BWR appears to be its potential for favorable effects on power distribution, reactivity control, and margins for core dynamic response. The most promising designs are those which selectively locate thorium-bearing rods to most effectively utilize the unique heterogeneity of the BWR lattice, which is composed of individually channeled fuel assemblies separated by water spaces. Mixed lattice designs with only a few ThO_2 rods were found to significantly improve dynamic and control characteristics.

583 (PNL-SA—6335) **Ex-reactor determination of thermal gap conductance between uranium dioxide—Zircaloy-4 interfaces.** Garnier, J.E.; Begej, S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1977. Contract EY-76-C-06-1830. 9p. (CONF-770847—9). Dep. NTIS, PC A02/MF A01.

From 15. international thermal conductivity conference; Ottawa, Ontario, Canada (24 Aug 1977).

A study of thermal gap conductance between UO_2 and Zircaloy-4 has been initiated utilizing a unique transient pulse technique: Modified Pulse Design (MPD)--a technique employing a heat pulse (laser) and signal detector to monitor the energy transmitted through UO_2-Zircaloy samples both in contact and separated by a gap. Initial experiments have been conducted as a function of temperature (to 873°K), gas composition (He, He : Ar, Ar), and gap width 6.0×10^{-4} and 2.18×10^{-3} cm). The thermal gap conductance is dependent upon these variables, and comparison with calculated results using existing models for the temperature jump distance is made. A new concept involving direct energy transfer across narrow gaps by individual gas molecules is also considered.

584 (UCRL—52383) **Air scaling and modeling studies for the 1/5-scale mark I boiling water reactor pressure suppression experiment.** Lai, W.; McCauley, E.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jan 1978. Contract W-7405-ENG-48. 90p. Dep. NTIS, PC A05/MF A01.

Results of table-top model experiments performed to investigate pool dynamics effects due to a postulated loss-of-coolant accident (LOCA) for the Peach Bottom Mark I boiling water reactor containment system guided subsequent conduct of the 1/5-scale torus experiment and provided new insight into the vertical load function (VLF). Pool dynamics results were qualitatively correct. Experiments with a 1/64-scale fully modeled drywell and torus showed that a 90° torus sector was adequate to reveal three-dimensional effects; the 1/5-scale torus experiment confirmed this.

585 **MITI prepares for standardization of LWR plants.** *At. Jpn.;* **21**: No. 5, 29-33(May 1977).

Feasibility studies on the standardization of LWR plants, aiming at minimizing the radiation exposure of workers and at improving workability, were reported by MITI (the Ministry of International Trade and Industry). The studies cover the improvements to the shape of reactor containments and the increased space within containments as well as equipment arrangement. The radiation exposure of workers in a standardized plant can be reduced by some 35% in BWRs and 25% in PWRs. Further reduction can be expected if preventive measures are taken against the corrosion in piping systems. The time required for regular inspection could be reduced. MITI plans to prepare the first stage of standard specifications in FY-77, and calls for utilities and suppliers to incorporate these results in all future LWR plants now under planning, including Sendai-I (PWR 800 MW) of Kyushu Electric Power Company and No. 2 unit (BWR 1,100 MW) of Fukushima-II of Tokyo Electric Power Company. At the first stage, the standardization is mainly focussed on reactor steam supply systems, and the arrangement of equipments and building design will be left to future studies. At the second stage, improvement and standardization will require relatively long term technological assessments, for which MITI plans to set targets after FY-77, aiming at completing the standard plant specifications of LWRs in Japan around FY-80.

586 **Physicochemical interactions at metal-water interfaces and their significance to deposition problems at nuclear power plants.** Venkateswaran, G.; VENKATESWARLU, K.S. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). CHEMISTRY DIV.). pp 176-186 of Proceedings of the symposium on chemistry and physics of surface of metals and their oxides. Bombay; Department of Atomic Energy (1977).

From Symposium on chemistry and physics of surface of metals and their oxides; Kalpakkam, Tamil Nadu, India (27 Jan 1976).

An attempt has been made to understand deposit formation in the general framework of interface processes involving : (1) surface potentials of the oxide particles which when released from the constructional materials are the main contaminants in the high temperature coolant water, (2) pH and (3) factors such as conductivity, temperature and velocity of coolant which influence surface potential. Measures suggested to avoid deposition formation are : (1) for new reactors, proper adjustment of the pH of various water systems and change of material of construction so as to minimise the force of attraction between the system surfaces and deposit forming species and (2) for existing reactors, replacement of certain parts like valve seals, orifice plate, strainers etc. by better compatible materials and even metallising certain surfaces so as to repel the circulating crud.

587 **Maintenance experience in the large turbine generators.** Kalaiya, J.B. pp 207-213 of Symposium on operating experience of nuclear reactors and power plants. Bombay; Department of Atomic Energy (1977).

From Symposium on operating experience of nuclear reactors and power plants; Bombay, India (7 Feb 1977).

Tarapur Atomic Power Station (TAPS) has two turbine Generators each of 210 MW(e) capacity associated with its respective units. The BWRs are dual cycle type, generating primary steam in reactor, and, secondary steam at reduced pressure in secondary steam generators with forced circulation in reactor core. The Reactor pressure (70 Kg/cm²) is required to be controlled within +- 0.10 Kg/cm². The secondary steam pressure is variable and steam supply is speed governor dependent. Normally TAPS is operated as a base load station. The actual operational experiences with the : (i) mechanical pressure regulators, (ii) load dump system, (iii) hydraulic system piping and (iv) hydraulic control system components are described. Turbine maintenance work which involves control of : (i) HP-casing flange leak, (ii) erosion damage on blades and (iii) loss of lubrication for T/G bearings is explained.

588 Performance of Tarapur Atomic Power Station. Nanjundeswaran, K.; RAMANAN, T.S.V.; SRIKANTA, S. pp 193-198 of Symposium on operating experience of nuclear reactors and power plants. Bombay; Department of Atomic Energy (1977).

From Symposium on operating experience of nuclear reactors and power plants; Bombay, India (7 Feb 1977).

Tarapur Atomic Power Station (TAPS) located on the West Coast of Bombay is the first twin unit Boiling Reactor (BWR) Nuclear Power Station in India and the only BWR station with a single reactor building in the world. This arrangement of two reactors in a single reactor building and many common station auxiliary systems are planned with a view to reduce building space and effect overall economy in plant outlay. The units are of early design dual cycle reactors of 660/706 MW thermal to 210/210 MWe rating each sharing common systems extensively. The station went into commercial operation from November 1969. Performance of the station during the 14 reactor operating years is discussed.

589 Lower tie plate in a fuel assembly. Yoshimoto, Y.; Ejiri, F. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-92,088/A/. 30 Jan 1976. 5p. (In Japanese).

The object of the invention is to prevent a coolant bypass flow from coming into direct contact with an in-pile measuring tube and to prevent leakage of the coolant inside a channel box. A through hole is provided in a portion opposite a finger spring on the side of a lower tie plate to partly inject the internal coolant toward the inside of the finger spring, and the finger spring is biased on the channel box in a required portion to prevent leakage of the internal coolant.

590 Preventive method against corrosion of reactor piping. Domon, K.; Suematsu, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-85,696/A/. 7 Jan 1976. 3p. (In Japanese).

The object of the invention is to prevent corrosion of pipe lines at the time of starting up a reactor so as to decrease a quantity of clad charged into the reactor. Before starting up the reactor, a coolant within a feed and condensation water pipe-line, which provides a communication between a condenser and a reactor vessel, is returned to the condenser through a branch pipe line, which provides a communication between the feed and condensation water pipe-line, to detect the concentration of oxygen in a soluble state within the pipe line, and the degree of vacuum of the condenser is adjusted in response to said detection signal to maintain the concentration of oxygen in a soluble state within the range from about 50 to 200 ppb, so that when the concentration of oxygen in a soluble state within the pipe line is not sufficient, oxygen enough to cover such short may be filled into the feed and condensation water pipe-line.

591 Coolant treatment system. Sakairi, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-85,697/A/. 7 Jan 1976. 4p. (In Japanese).

The object of the invention is to improve environmental conditions of a circulating pump to secure all of operating modes. In a coolant treatment system in the form of a closed circuit comprising a reactor, a circulating pump, a heat exchanger and means for removing impurities, said circulating pump is arranged at outlet of said impurity removing means, and utilizable net suction water head securing devices each composed of a bypass pipe and a valve are mounted at inlet and at outlet of the circulating pump, whereby said each valve may be switched so that the circulating pump is positioned at inlet and at outlet of said impurity removing means.

592 Neutron flux detector. Yoshimoto, Y. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-85,695/A/. 7 Jan 1976. 6p. (In Japanese).

The object of the invention is to prevent vibrations of a neutron flux detector and to enable individual replacement of neutron detection terminals within the neutron flux detector. A detector tube, which is inserted in a core portion extending through the lower portion of a reactor vessel and a core-bottom supporting member disposed within the reactor vessel, is secured to the reactor vessel and the core-bottom supporting member, guide tubes arranged within the detector tube are guided outside the reactor vessel, each of said guide tubes having a neutron detection terminal detachably inserted therein, and a coolant passage, which communicates a region lower than the core-bottom supporting member with the core portion within the reactor vessel, is provided interiorly of the detector tube.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 580, 583, 585, 586, 662, 705, 716, 753, 755, 757, 762, 770, 771, 772, 775, 776, 777, 780, 783, 784, 786, 787, 789, 795, 800

593 (BNL—24612) In situ corrosion monitoring of steam generators. Kendig, M.W.; Isaacs, H.S. (Brookhaven National Lab., Upton, NY (USA)). Jun 1978. Contract EY-76-C-02-0016. 27p. (CONF-780920—1). Dep. NTIS, PC A03/MF A01.

From Working party on stress corrosion cracking test methods; Firminy, France (19 Sep 1978).

An ac electrochemical technique which meets the basic requirements for an in situ localized corrosion monitor within the secondary coolant of PWR steam generators has been investigated. The technique uses two electrodes to measure the electrochemical impedance of a surface in an occluded region with high heat flux. The impedance is related to the kinetics of corrosion. Marked decreases indicate the onset of a high corrosion rate. Experiments have demonstrated the ability of the technique to determine the onset of corrosion under conditions of high solution resistance and solution agitation due to local boiling. Experiments have shown the technique operates similarly in pressurized 300°C water, 1,400 ppM in Na_2SO_4.

594 (COO—4570-4) Design and fuel management of PWR cores to optimize the once-through fuel cycle. Fujita, E.K.; Driscoll, M.J.; Lanning, D.D. (Massachusetts Inst. of Tech., Cambridge (USA). Energy Lab.). Aug 1978. Contract EN-77-S-02-4570. 249p. (MITNE—215; MIT-EL—78-017). Dep. NTIS, PC A11/MF A01.

The once-through fuel cycle has been analyzed to see if there are substantial prospects for improved uranium ore utilization in current light water reactors, with a specific focus on pressurized water reactors. The types of changes which have been examined are: (1) re-optimization of fuel pin diameter and lattice pitch, (2) axial power shaping by enrichment gradation in fresh fuel, (3) use of 6-batch cores with semi-annual refueling, (4) use of 6-batch cores with annual refueling, hence greater extended (approximately doubled) burnup, (5) use of radial reflector assemblies, (6) use of internally heterogeneous cores (simple seed/blanket configurations), (7) use of power/temperature coastdown at the end of life to extend burnup, (8) use of metal or diluted oxide fuel, (9) use of thorium, and (10) use of isotopically separated low sigma/sub a/ cladding material. State-of-the-art LWR computational methods, LEOPARD/PDQ-7/FLARE-G, were used to investigate these modifications.

595 (IKE—6-115) Comparison of two one-dimensional methods of calculation for determining the flux density spectrum of a PWR fuel element. Baur, G.; LUTZ, D. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Oct 1977. 29p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

For the determination of few-group cross sections for PWR fuel elements, usually a multigroups spectrum calculated for a one-dimensional supercell is applied. In the present paper, this model is compared with a method accounting for the fuel rod cell and also for the control rod guide thimble cell in the geometrically correct manner. By the example of the the BIBLIS fuel elements, the multigroup spectra of both methods of calculation are compared with one another and the differences in the resulting two-group cross sections are examined. The deviations obtained amount to less than 1% for the spectra and the cross sections.

596 (NUREG—0452) Standardized Technical Specifications for Westinghouse PWRs. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). 15 Jun 1978. 591p. NTIS $16.50.

This Standard Technical Specification (STS) has been structured for the broadest possible use on Westinghouse plants currently being reviewed for an Operating License. Accordingly, the document contains specifications applicable to plants (1) with either 3 or 4 loops and (2) with and without loop stop valves. In addition, four separate and discrete containment specification sections are provided for each of the following containment types: Atmospheric, Ice Condenser, Sub-Atmospheric, and Dual. Optional specifications are provided for those features and systems which may be included in individual plant designs but are not generic in their scope of application. Alternate specifications are provided in a limited number of cases to cover situations where alternate specification requirements are necessary on a generic basis because of design differences. The format of the STS addresses the categories required by 10 CFR 50 and consists of six sections covering the areas of: Definitions, Safety Limits and Limiting Safety System Settings, Limiting Conditions for Operation, Surveillance Requirements, Design Features, and Administrative Controls.

597 (WCAP—8252(Rev.1)) Documentation of selected Westinghouse structural analysis computer codes. (Westinghouse Electric Corp., Pittsburgh, PA (USA)). May 1977. 257p. Westinghouse Electric Corp., Pittsburgh, PA.

This topical report presents representative verification and qualification of the selected Westinghouse structural analysis computer codes. The selected codes include WESTDYN7, FIXFM3, WESDYN2, STRUDL, THESSE, WECAN, SAND, SPECTA, MODAL, DARI-WOSTAS and STHRUST which are utilized in

dynamic and static analyses to determine forces, stresses and deformations of components. The verification and qualification follow the established Westinghouse procedures and instructions which are in compliance with the AEC and the ASME regulations for design control and documentation. Capability and description of each code are provided to give information on the basic features and methods adopted.

598 Status and trends in nuclear technology for power plants with WWER-1000 reactors. Review. Zorev, N.N. *At. Energ. (USSR);* **42**: No. 4, 295-303(Apr 1977). (In Russian).

The problems of improving quality of nuclear equipment for WWER-1000 power plants and associated nuclear technology automation are surveyed. Examples of technological innovations are presented which significantly reduce labour intensity, time consumption and increase quality standards of the products. Some new automated equipments for materials welding, working, machining and quality control are described. The discussion is centering around heavy-section steel technologies. Some mechanical properties of new-developed nuclear grade steels designed for producing reactor vessels and steamgenerators, volume compensators and pipes, as well as steam separators and steamsuperheaters are also presented. Their properties (impact strength and radiation resistance) are pointed out to be superior to that of steels used abroad. The basic trend in nuclear structural material developments is towards integrated optimization of strength, performance and workability.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 698, 878, 879, 880

599 (EPRI-NP—805) **Technology assessment of the Gas-Turbine-High Temperature Gas-Cooled (helium) Reactor. Interim report.** Scarborough, J.C. (NUS Corp., Rockville, MD (USA)). Jun 1978. 264p. Dep. NTIS, PC A12/MF A01.

This report, which examines the Gas Turbine-High Temperature Gas-Cooled Reactor (GT-HTGR), derives from related technology assessments initiated in 1976. Those EPRI assessments, which were intended as companions to government-funded reactor commercialization studies, addressed the technical adequacy of a specific steam-cycle HTGR design. The same approach has been utilized herein except as limited by the more conceptual nature of the GT-HTGR. The GT-HTGR has historically been viewed as an international program deriving from U.S. graphite-helium reactor technology and European closed cycle turbomachinery development. In concept the program has been remarkably stable, but schedules and specific designs have been subject to continuing modification largely as a result of changes in national energy policies. The specific purposes of this report are (a) to provide a brief review of the recent international background of the project and (b) to discuss the open issues and technical risks which appeared evident in the technical literature available through 1977. The chronology of GT-HTGR development in both the United States and Europe through 1977 is summarized. A detailed reporting of technical evaluations and verification analyses performed is included.

600 (GA-A—14757) **Core design feasibility study for LEU- and MEU/Th-fueled HTGRs.** Asmussen, K.E.; Ganley, J.T. (General Atomic Co., San Diego, CA (USA)). Jun 1978. Contract EY-76-C-03-0167-065. 109p. Dep. NTIS, PC A06/MF A01.

The core design studies included an investigation of the impact of MEU/Th and LEU fuel on core design methods, identification of potential problem areas, schemes for effecting the transition from the present HEU cycle in Fort St. Vrain to an MEU/Th or LEU cycle, and a study of the impact on core and plant operation. Results of radial and axial burnup studies are presented, together with a brief core performance analysis. Although the greatest portion of the study was concerned with the impact of an MEU/Th cycle in Fort St. Vrain, results for LEU cycles in Fort St. Vrain and for MEU/Th cycles in the large HTGR (Lead Plant) are also presented.

601 (GA-A—14839) **GCR reliability data bank status report.** Hannaman, G.W. (General Atomic Co., San Diego, CA (USA)). Jul 1978. Contract EY-76-C-03-0167-023. 60p. Dep. NTIS, PC A04/MF A01.

This report illustrates the practical synthesis of component and system operating experience into reliabilty parameters which are used in probabilistic risk evaluations of gas cooled reactors (GCRs). Component and system reliability parameters have been extracted from over 65 sources of reliability data, which are classified into four groups: (1) gas cooled reactor data, (2) U.S. nuclear and fossil fired data, (3) summarized data, and (4) special reliability analysis estimates. The data from these sources are synthesized into generic failure rate estimates with variability ranges for GCR components and their failure modes. Repair times are also given. Either this synthesized information or the basic reference documents can be used to quantify the component level data inputs to fault trees for the probabilistic evaluation of hypothesized GCR accident sequences. This collection of data supports the DOE-funded Accident Initiation and Progression Analysis (AIPA).

602 (Juel—1459) **Experimental check of models and data to describe the resonance-absorption in HTR-fuel.** Kloth, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Sep 1977. 81p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Thesis.

Measurements of effective resonance integrals of spherical HTGR fuel assemblies are performed. These measurements were carried out to test calculations models taking into account the influence of the grain structure on the effective resonance integral caused by the use of coated particles. Further the resonance overlap of these resonance absorber is examinated. It shows, that there is in general a good agreement between measurement and calculation. In addition to earlier investigations of the resonance absorption of Hafnium, investigations on the doppler effect on resonance absorption have been performed at temperatures up to 500°C. Calculation for the Hafnium resonance integral using the computer program GAROL with the modified set of resonance parameters show good agreement with the measurements. These calculations give also a way to determine the resonance integral for infinite dilution.

603 Effect of radiation heat transfer on the performance of high temperature heat exchanger, (2). Case of radiating gas. Yamada, Y. (Mechanical Engineering Lab., Tokyo (Japan)); Mori, Y.; Hijikata, K. *Nippon Kikai Gakkai Rombunshu;* **43**: No. 369, 1879-1888(May 1977). (In Japanese).

In high temperature helium gas-cooled reactors, the nuclear energy can be utilized effectively, and the safety is excellent as compared with conventional reactors. They are advantageous also in view of environmental problems. In this report, the high temperature heat exchanger used for heating steam with the helium from a high temperature gas reactor is modeled, and the case that radiating gas flow between parallel plates is considered. Analysis was made on the case of one channel and constant heat flux and on the model for a counter-flow type heat exchanger with two channels, and the effect of radiation on the heat transfer in laminar flow and turbulent flow regions was clarified theoretically. The basic equations, the method of approximate solution and the results of calculation are explained. When one dimensional radiation was considered, the representative temperature Tr regarding fluid radiation was introduced, and its relation to mean mixing temperature Tm was determined. It was clarified that the large error in the result did not arise even if Tr was taken equally to Tm, especially in case of turbulent flow. The error was practically negligible when the rate of forced convection heat transfer in case of radiating medium flow was taken same as that in the case without radiation.

604 Behavior of active corrosion products in a system of boiling water power channel type reactor of a single-circuit NPP. Gruzdev, N.I.; Shchapov, G.A.; Boguslavskii, V.B.; Petukhov, Yu.I. *Teploenergetika (Moscow);* No. 1, 70-72(Jan 1977). (In Russian).

Studies were made at a single-loop NPP with a boiling AMB-2 reactor under stand and industrial conditions, of the behaviour of radioactive products of corrosion in the main circulation loop depending on the choice of waterchemical conditions and on the working technological conditions at the station. Estimates were made of the ability of various construction materials used at NPP (stainless steel, zirconium alloys, carbon steel) to absorb radioactive isotopes from the coolant. The studies were made under two sorts of water-chemical conditions, viz. with ammonia treatment of water or under noncorrection water conditions. The reactor worked under both steady-state and transient conditions. On the basis of the studies one can state that at NPP with boiling reactors the noncorrection water regime, from the stand point of the formation of radioactive deposits in the loop outside the active zone and considerations of radiation safety, should be preferred over the ammonia one. The results of the studies have shown that zirconium alloys exhibit the greatest sorbing ability, next comes carbon steel and, finally, stainless steel.

605 Tamokuteki koon gasuro kenkyu kaihatsu no genjo, 1977-nenban. (Present status of research and development of a multi-purpose high-temperature gas cooled reactor in 1977). Tokyo, Japan; Japan Atomic Energy Research Inst. (1977). 82p. (In Japanese).

Appreciating the need for multi-purpose utilization of nuclear heat energy, JAERI has engaged in research and development of a multi-purpose high-temperature gas cooled reactor since 1969. The present status is described with emphasis on results in the past year: design studies, fuel/graphite such as coated fuel particle, thorium

fuel and fuel reprocessing, heat-resisting metal materials, heat transfer, reactor physics/engineering including instrumentation and control, high-temperature machinery and structures including core aseismicity, and high-temperature irradiation techniques including post-irradiation test.

606 Core-supporting device in a gas cooling type reactor. Kobayashi, O.; Yukishima, I. (to Fuji Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1977-98,888/A/. 14 Feb 1976. 4p. (In Japanese).

The object of the invention is to simplify construction and decrease leaks. A load supporting structure is located below a core bottom block structure to carry weight of the core. In the above-mentioned supporting structure, each column-shaped supporting member is fixedly arranged corresponding to a position of said block. Further, a seal plate is placed on the column-shaped supporting member extending through a level adjusting bolt and retained by a nut. The level adjusting bolt has an upper spherical seat slipped in a faced concave formed in the bottom surface of the core bottom block structure.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 703, 704

607 (CEGB-RD/B/N—3874) **Measurement of ^{41}Ar release rates at magnox stations.** Wilson, R. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Nov 1977. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Shield cooling air from early Magnox reactors contains quantities of ^{41}Ar produced by neutron capture in the ^{40}Ar which comprises approximately 1% of air. Investigations of annual cloud-gamma exposures at ground level due to ^{41}Ar and the associated collective doses to the population require the actual release rates of ^{41}Ar from sites. A programme of ^{41}Ar release rate measurements has therefore been carried out at Berkeley, Bradwell, Dungeness A, Hinkley Point A, Sizewell A and Trawsfynydd. A detailed account is given of the experimental method employed. A measured release rates were corrected for station power and annual load factor to give the annual ^{41}Ar release rates for 1975 and 1976. The corrected values lay within the range 16,000 to 152,000 Ci year^{-1} (0.5 to 4.8 mCi s^{-1}).

608 Portable ionization chamber type gamma compensated tritium monitor for instantaneous detection of localised tritium activity releases. Kadwani, M.G.; RATHNAKARAN, M.; SINGH, A.N. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). AIR MONITORING SECTION). pp 65-71 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

A portable ionization type monitor designed for instantaneous detection of tritium activity releases in heavy water moderated and cooled reactors is described. Two ionization chambers are operated in the subtraction mode so as to compensate for background gamma radiation and assay the tritium levels. Design details are given.

609 Instrument for the continuous monitoring of tritium activity in the air in heavy water reactors. Singh, A.N.; KADWANI, M.G.; NAIR, N.B.; MURTHY, M.V.R.; RATHNAKARAN, M. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). AIR MONITORING SECTION). pp 72-82 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

Various types of detectors used for monitoring tritium activity levels in heavy water moderated and cooled reactors and their relative merits are outlined. The recent improvements in monitoring systems have been attempted by using perforated plastic scintillator films. These detectors are 50 to 60% more sensitive and the limit of tritium detection is as low as 2μci/cm^3 or 0.002 MPC. Design of a monitoring system incorporating such a detector and experience gained are described.

610 Plutonium and uranium recycle and neutron regeneration in a thermal power reactor. Khristenko, P.I. *At. Energ. (USSR);* **42**: No. 4, 272-276(Apr 1977). (In Russian).

The problem of improving nuclear fuel utilization in thermal reactors is analyzed. A conceptual design of a HWGCR type power reactor is put forward which provides for increased conversion rates and approximately 15 per cent burnup of natural uranium used. ^{238}U fuel with equilibrium concentrations of $^{239,241}Pu$ and additions of ^{235}U in the form of natural uranium is used. High fast neutron multiplication factors of the fuel, breeding blankets for neutron regeneration and U and Pu recycle provide for the high efficiency of the reactor. As applied to the KC-150 reactor core neutron balance and nuclear fuel optimum burnup are evaluated. The HWGCR type reactors utilizing the U-Pu fuel cycle are concluded to be able to expand substantially the nuclear fuel base of thermal power reactors.

611 Turbine bearing problem in the first 220 Mwe unit of R.A.P.P. Bohra, S.A. (RAJASTHAN ATOMIC POWER PROJECT, KOTA (INDIA)). pp 218-225 of Symposium on operating experience of nuclear reactors and power plants. Bombay; Department of Atomic Energy (1977).

From Symposium on operating experience of nuclear reactors and power plants; Bombay, India (7 Feb 1977).

The problems connected with turbine bearing in the Unit I of the Rajasthan Atomic Power Station are described. The systematic analysis of the problem, such as review of bearing design, bearing speed, bearing metal, effective cleanliness of the system, properties of the oil, erection of oil piping, etc. are mentioned. Modifications carried out in the Unit-II as well as suggestions for future units are outlined.

612 Turbine blade failures and the rehabilitation at Rajasthan Atomic Power Station. Mathur, P.K.; CHANDRA, AVINASH (RAJASTHAN ATOMIC POWER STATION, KOTA (INDIA)). pp 214-217 of Symposium on operating experience of nuclear reactors and power plants. Bombay; Department of Atomic Energy (1977).

From Symposium on operating experience of nuclear reactors and power plants; Bombay, India (7 Feb 1977).

The Rajasthan Atomic Power Station turbine is a horizontal impulse reaction type and consists of a single high pressure cylinder and two double flow low pressure cylinders. It runs at 3000 r.p.m. and is rated for 220 MWe generation. General performance of the turbine since commissioning is described in brief. The three turbine blade failures which have occurred between July 1974 and July 1975 are explained in detail. The inspection procedure adopted, the extent of damage caused and the rehabilitation techniques followed are all outlined. An attempt is made to point out the possible causes for the turbine blade failures.

613 Fuel assembly. Nishi, A.; Minazuki, I. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1977-87,595/A/. 13 Jan 1976. 3p. (In Japanese).

The object of the invention is to provide a fuel assembly particularly for use with a pressure tube type heavy-water-moderated power reactor, which can simplify adjusting work for the purpose of forming power distribution into uniformity. Burnable poison-containing wires whose diameter is selected are passed over externally of fuel rods in a fuel assembly or spirally wound about the outer surface of a clad tube. With the burnable poison formed into wires as described above, power may be adjusted in a simple manner and it is advantageous in the management of a nuclear fuel.

614 Failed fuel detection system. Aggarwal, S.K.; HORA, H.S.; KHASNABIS, C.K.; MADAN, V.D.; NARASAIAH, A.; PATKI, S.N. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA)); NATARAJAN, K. (DEPARTMENT OF ATOMIC ENERGY, BOMBAY (INDIA). PHYSICS COMMITTEE). pp 18-24 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

The failed fuel detection system used at the Rajasthan Atomic Power Station consists of : (i) two count rate meter units, (ii) data acquisition unit, (iii) batch selector and driver unit, (iv) data display unit and (v) power supply unit. Each unit is described in detail. The performance of this system is satisfactory. Some improvements are suggested.

615 Proposed experiments for parametric study of four methods of detecting and locating failed fuel elements in reactor. Dhodapkar, S.D.; ARORA, K.K.; JINDAL, R.N.; MENEZES, P.F.; GUPTA, S.K.; BHUTIANI, R.L. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA)). pp 25-29 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

Four methods of failed fuel element detection viz., (1) delayed neutron monitoring, (2) gaseous fission product monitoring, (3) I^{131} monitoring and (4) MO^{99} and Te^{132} monitoring (trap method) are described and the suitability of each method for use at the Rajasthan Atomic Power Station, is discussed.

616 Some investigations into the behaviour of ^{131}I activity in PHT system of RAPS. Dhodapkar, S.D. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA)). pp 30-34 of Sympo-

sium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

The behaviour of ^{131}I activity in the primary heat transfer system of the reactors of the Rajasthan Atomic Power Station is explained. The phenomenon of "cooling bursts" is explained which most probably plays part in peaking of activity during shutdown. It is shown that monitoring of ^{131}I activity in the coolant can be used for detection of fuel element failure.

617 Development of on-line boron analyser for D_2O moderator system of power reactors. Reddy, G.R.; SANKAR DAS, M. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). ANALYTICAL CHEMISTRY DIV.); MENON, K.R.; VARTAK, D.G. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). REACTOR CHEMISTRY SECTION). pp 46-52 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

Boric acid is increasingly used as a liquid poison in heavy water moderator systems of power reactors for controlling the reactivity during the start-ups. A method developed for continuous monitoring of boron-10 concentration in the moderator is described. Based on the principle of neutron flux depression, the experiments have been carried out using a 1 ci ^{239}Pu-Be neutron source. A sensitivity of about 0.2 ppm ^{10}B is obtained.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 601, 697, 700, 725, 749, 750, 751, 756, 759, 760, 774, 778, 782, 788, 794, 799, 804, 878, 879, 880, 1020, 1082

618 (AI-DOE—13238) Selection of bearing materials for commercial LMFBR flexible joint applications. Kuster, C.A.; Sarraf, R.J.; Tsang, S. (Atomics International Div., Canoga Park, CA (USA)). 7 Jul 1978. Contract EY-76-C-03-0824-019. 73p. AT.

Results of the verification and test program conducted for selecting a bearing couple for hinge assemblies of the angular flexible joint for use in primary LMFBR piping are reported. Initial screening phase friction and wear tests and thermal cycling tests were performed on 13 bearing material combinations in a nitrogen environment. These bearing combinations, selected from a wide range of bearing materials and combinations studied in a literature survey, were considered to be the most promising to meet the requirements of the system. Final friction and wear testing of the best four bearing combinations were conducted in both nitrogen and air environments. Two bearing combinations, K162B/K162B and Tribaloy 700/Colmonoy 6, are recommended for further evaluation in prototypic testing.

619 (ANL-CT—78-40) UK/USA core restraint exchange study NUBOW-3D results. McLennan, G.A. (Argonne National Lab., IL (USA)). Jul 1978. Contract W-31-109-ENG-38. 73p. AT.

Core restraint structural analyses were performed for a model of the National Core Restraint Test Facility (NCRTF) for a series of loading conditions. These calculations were performed using the computer code NUBOW-3D, to form a basis for comparison with results to be obtained through a cooperative agreement with the United Kingdom, from the UK code CRAMP. This UK core restraint code includes a friction capability and the results of this comparison will be used to assess the effects of friction on US core restraint analysis and design. The report summarizes the NUBOW-3D modeling of the NCRTF to be compatible with the UK code and presents the (frictionless) NUBOW-3D results for a series of selected loadings, including compaction by movable yokes at the above-core-load-plane, and an assumed thermal rise to power for a specified temperature distribution.

620 (BR-E—180(Vol.2)) PLBR Phase II: (follow-on) reports. (Burns and Roe, Inc., Oradell, NJ (USA)). 30 Sep 1977. Contract EY-76-C-03-1145. 203p. AT.

Engineering program objectives include work in the following areas: labyrinth shielding of primary piping; HTS cell layout; steam cycle design basis; reactor cavity structure gamma heating; and reactor support ledge and pipe penetration cooling.

621 (CONF-780922—2) Maintenance of Clinch River Breeder Reactor Nuclear Island Systems. Ehrman, C.S.; Burgess, D.S. (Burns and Roe, Inc., Oradell, NJ (USA); Atomics International Div., Canoga Park, CA (USA)). 1978. Contract EN-77-C-03-1547. 18p. Dep. NTIS, PC A02/MF A01.

From ASME conference on power generation; Dallas, TX, USA (10 Sep 1978).

The Clinch River Breeder Reactor Plant is being designed to be maintained so that a high plant availability goal can be achieved. The plant is being designed so that equipment disassembly, cleaning, repair, reassembly, and return to service can be conducted in an expeditious manner. The layout of the plant and of individual cells provides adequate accessibility, work clearance, laydown areas, removal paths, and handling areas. Wherever possible, the plant systems have been designed to provide capability for hands-on inspection and maintenance without undue hazard to maintenance personnel. Major sodium system components are removed by special transfer and bag-out techniques and placed in shielded casks when required. Systems and facilities have been provided for removal of sodium and decontamination of components, supported by Radwaste Systems which provide for control and disposition of radioactive wastes generated or released during maintenance.

622 (CRBRP-GEFR-SP—00043) Comparison of results from large-leak sodium/water tests at LLTR with analysis. Meyer, R.A.; Bradfute, J.O.; Lee, L.S.; Regimbal, J.J. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). Feb 1978. . 27p. (CONF-780203—6). AT.

Pre-test analyses performed for the Series I Large Leak Test Rig (LLTR) tests using the TRANSWRAP II computer code are described. These pre-test predictions are compared to the test data and significant differences between the pre-test analyses and the data are evaluated. These evaluations include three major areas: the source term, acoustic transmission of pressure disturbances, and the response of the LLTR sodium-water reaction relief system. The degree of conservatism in the analytical predictions is assessed and some possible areas for reducing conservatism in the analysis are identified.

623 (DOE/ET—0050/1) Performance measurement system: system description. (Department of Energy, Washington, DC (USA). Div. of Reactor Research and Technology). 28 Jan 1977. 27p. (RDD/PMS—1). Dep. NTIS, PC A03/MF A01.

The summary description describes the Performance Measurement System (PMS) and Mini-Performance Measurement System (Mini-PMS) used by the Reactor Development and Demonstration Division (RDD) on selected contracts within Division projects. The intent of the pamphlet is to provide a summary description of the two systems and their operation for the benefit of ERDA and industry personnel. As its name implies, Mini-PMS is a derivative of PMS. Basically, PMS and Mini-PMS differ only in that Mini-PMS is a less rigid version of PMS. The general differences between PMS and Mini-PMS in the areas of their application, implementation, and operation are listed and discussed.

624 (DOE/ET—0050/4) Performance measurement system: data analysis guide. (Department of Energy, Washington, DC (USA). Div. of Reactor Research and Technology). 30 Mar 1976. 80p. (RDD/PMS—4). Dep. NTIS, PC A05/MF A01.

This guide provides a framework for using data generated by a management control system that complies with the requirements of the RDD Performance Measurement System (PMS). It was developed to assist ERDA Managers in their roles as decision makers. It presents: (1) types of data that are available, (2) various data analysis techniques applicable, (3) depiction of the data, and (4) benefits from use of the data.

625 (DOE/ET—0050/5) Performance Measurement System: surveillance guide. (Department of Energy, Washington, DC (USA). Div. of Reactor Research and Technology). 30 Mar 1976. 58p. (RDD/PMS—5). Dep. NTIS, PC A04/MF A01.

The guide provides uniform guidance for the Reactor Development and Demonstration Division (RDD) and other Energy Research and Development Administration (ERDA) organizations responsible for surveillance of the RDD Performance Measurement System (PMS) criteria for cost and schedule control systems. Guidance for implementation of the PMS criteria and acceptance of a contractor's management control system is provided in RDD/PMS-2, PMS Implementation Guide. The procedural guidance contained in the guide should be adapted to specific organizational structures and to specific situations as they arise. Details concerning the PMS surveillance of each contractor's management control system should be developed by the Cognizant Contracting Office (CCO), coordinated with the Cognizant Federal Auditor (CFA), and agreed upon by RDD Project Management. Any procedures employed should be consistent with the guidance contained herein and in the PMS Implementation Guide. The guidance furnished will provide assistance to: (1) RDD Project Management in formulating surveillance plans and determining resource requirements; (2) RDD surveillance personnel in accomplishing their surveillance functions; and (3) contractors in understanding the requirements of the surveillance program and responding to them.

626 (DOE/ET—0050/6) Performance Measurement System: work breakdown structure (WBS) guide. (Department of Energy,

Washington, DC (USA). Div. of Reactor Research and Technology). Apr 1978. vp. (RDD/PMS—6).

The guide provides guidance on the use of the Work Breakdown Structure (WBS) technique to Reactor Development and Demonstration Division (RDD) managers responsible for projects supporting the LMFBR Program. The guide covers the types of WBSs, how and by whom they are prepared, and how they should be used by RDD and contractors for effective management and control.

627 (DOE/ET—0050/7) **Performance measurement system: Mini-PMS guide.** (Department of Energy, Washington, DC (USA). Div. of Reactor Research and Technology). 14 Jan 1977. 72p. (RDD/PMS—7). Dep. NTIS, PC A04/MF A01.

This document provides guidance to Reactor Development and Demonstration Project Management and contractors on the use of the Mini-Performance Measurement System (Mini-PMS) as a contract management tool. As its name implies, Mini-PMS is a derivative of the RDD Performance Measurement System (PMS) applied to selected contracts/subcontracts within major RDD projects. Mini-PMS differs from PMS in that Mini-PMS does not require that contractors' management control systems comply with a set of criteria for such systems and offers a more flexible approach to contract performance reporting. Mini-PMS is applied to contracts which require visibility and control in order to meet the contract and related project objectives. In addition, contractors should consider applying Mini-PMS to their subcontracts. Mini-PMS supports the Project Management functions through a series of interrelated RDD/contractor activities that include: (1) development and use of work breakdown structures (WBSs) that define and organize the project/contract work; (2) use of contractor management control systems that facilitate performance measurement within the WBS framework; and (3) use of a reporting system based on Mini-PMS data elements to report contract status. When combined, these activities provide the means for correlating the contract's cost, schedule, and technical accomplishments.

628 (GEFR—00260) **Prototype large breeder reactor. Phase II. Extension studies. Part II. Reactor assembly.** (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). Sep 1977. Contract EY-76-C-03-1143. 203p. TIC.

Portions of document are illegible.

The seismic analysis of the PLBR loop reactor design was accomplished with two distinct finite element models in order to obtain a complete picture of the stresses in the reactor assembly. Although only one model is discussed in detail, this summary discusses the results of both the models. The axisymmetric model and the stick model were subjected to the same input seismic excitation. Two conservative approximations of the complete PLBR response spectrum were used. They were the spectra for horizontal excitation specified by: (1) the USAEC Regulatory Guide 1.60 and (2) the Bechtel Corporation based on a preliminary analysis of the PLBR structure. Two-thirds of each of the horizontal spectra were applied to the models in the vertical direction in order to investigate the reactor response to vertical motion.

629 (GEFR—00260(Pt.1)(Summ.)) **Prototype large breeder reactor. Phase II Extension studies. Part I. Summary.** (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). Sep 1977. Contract EY-76-C-03-1143. 24p. AT.

The Prototype Large Breeder Reactor design project has been performed in two distinct work phases. During the Phase I the plant characteristics and design criteria were established during a period of tradeoff studies. The major features established during Phase I were: power, temperature, steam cycle, number of loops, component and system features, refueling schemes, and research and development needs. During Phase II an overall conceptual design for PLBR was established and the initial plant design essentially completed in the following areas: core, components, systems, structures, research and development needs, and project schedule. The reactor assembly and heat transport systems are described.

630 (GEFR—00260(Pt.3)) **Prototype Large Breeder Reactor. Phase II. Extension studies. Part III. Heat transport systems.** (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). Sep 1977. Contract EY-76-C-03-1143. 360p. AT.

The transient analysis during PLBR Phase II Extension was broken into four specific areas. These are (1) to determine the sensitivity of the reactor scram transient for both the saturated and superheat cycle designs to a range of possible decay heat and initial power levels, (2) to investigate the potential for improving the reactor scram transient for the superheat cycle design(3) to evaluate selected transients during single-loop component failures without a reactor scram for the saturated cycle design and (4) to evaluate the drum vent failure transient followed by a reactor scram for the saturated cycle design.

631 (GEFR—00320(Vol.1)) **Clinch River reload core design study. Volume I. Trade-off study and design recommendations.** Deane, N.A. (comp.). (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). Feb 1978. Contract EY-76-C-03-0893-031. 252p. AT.

This is the final report of the General Electric portion of a year-long study to conceptually design advanced reload replacement cores for the CRBR. General Electric was to examine the potential of advanced oxide fuel replacement cores using advanced design concepts and advanced materials. Two objectives were established at the outset for the study. They were: to study the potential for improvements in compound system doubling time (CSDT) for future core reloads; and to study the potential for increases in thermal power output for future core reloads. General Electric analyzed in detail a minimum CSDT core and a high power (20 to 30 percent greater than the current design) core in order to understand the total performance potential for CRBR. A 40-year CSDT core which represents a 15-year improvement over the reference core was also analyzed during the trade-off studies.

632 (GEFR—00357) **Core restraint seismic test plan.** Yang, T.M. (General Electric Co., Sunnyvale, CA (USA). Fast Breeder Reactor Dept.). Mar 1978. Contract EY-76-C-03-0893-031. 18p. AT.

This test plan responds to Task 5 (Seismic Testing Plan) of the GE-FBRD plan for the evaluation of core restraint seismic response. The test plan has been developed with the assumption that the testing can be performed utilizing the FFTF Hydraulic Core Mockup (HCM) located at HEDL. The level of detail contained in this document is sufficient for HEDL to make cost and schedule estimates for the testing. This document also serves as a vehicle to obtain comments on the proposed seismic tests from the core restraint/seismic communities.

633 (HEDL-SA—1343) **Pulsed magnetic welding of breeder reactor fuel pin end closures.** Brown, W.F.; Bandas, J.; Olson, N.T. (Hanford Engineering Development Lab., Richland, WA (USA); Maxwell Labs., Inc., San Diego, CA (USA)). [nd]. Contract EY-76-C-14-2170. 14p. (CONF-780406—4). Dep. NTIS, PC A02/MF A01.

From 59. AWS annual meeting; New Orleans, LA, USA (3 Apr 1978).

High-frequency, high-intensity pulsed magnetic fields were used in an experimental program to produce leak proof fuel pin end closures on stainless steel and nickel base alloys. Metallographic examination of these solid state welds between thin walled fuel pin cladding tubes and end plugs showed a wavy or rippled appearance which is characteristic of high velocity impact bonding. Leak tests and mechanical tests showed that the end closure welds were leak proof and stronger than the cladding tube material.

634 (HEDL-SA—1375) **EBR-II validated, key fission product yields for fast reactor application.** Kellogg, L.S.; Davis, A.I.; Lippincott, E.P.; Ruggles, J.M. (Hanford Engineering Development Lab., Richland, WA (USA)). 1978. Contract EY-76-C-14-2170. 15p. (CONF-781002—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 2. symposium on reactor dosimetry; Palo Alto, CA, USA (3 Oct 1978).

Relative fission yields were measured for three different locations in the row 4 "Test Region" of the EBR-II reactor. Correlation of the relative fission yields to the measured average energy (anti E) and the measured ^{137}Cs $^{238}U/^{235}U$ spectral indices have been made. The measured relative fission yields for selected fission products from ^{235}U, ^{238}U, ^{239}Pu and ^{237}Np have been compared with those values reported by the Interlaboratory Reaction Rate (ILRR) program, EBR-II fast reactor yields from destructive analysis and summation, and the March 1977 version of ENDF/B-V.

635 (HEDL-SA—1405) **Comparison of fuel pin deformations with pressurized tube creep tests.** Taylor, J.P.; Gilbert, E.R.; Lovell, A.J. (Hanford Engineering Development Lab., Richland, WA (USA)). Jun 1978. Contract EY-76-C-14-2170. 27p. (CONF-780722—7). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 9. symposium on effects of radiation in structural materials; Richland, WA, USA (10 Jul 1978).

Fuel pins are a key component in the Fast Breeder Reactor; and the economical performance of the reactor depends upon the behavior and life of fuel pin assemblies. One of the limiting phenomena in fuel pin and assembly performance is deformation. A thermomechanical performance code "SIFAIL" is being used at HEDL to predict fuel cladding deformation. SIFAIL utilizes empirical descriptions of cladding strain as a function of temperature, stress and neutron fluence to predict fuel pin profiles. The equations are derived primarily from in-reactor tests on tubes pressurized with an inert gas and irradiated under conditions of constant temperature and stress. These equations were modified in SIFAIL to account for the variations in temperature and stress with time which occur in fuel pins. It is the purpose of these investigations to develop analytical methods which can be used to design fuel pins with optimum long life performance. Equations were developed to describe the in-

reactor creep behavior for two different classes of AISI 316 stainless steel tubing; a developmental class for the FTR and the FTR first code tubing. The behavior of these two tubing classes were sufficiently different that two distinctly separate equations were required to describe their in-reactor creep behaviors.

636 (HEDL-SA—1420) **Effect of sodium environment on breeder reactor components.** Eichelberger, R.L.; Brehm, W.F. (Liquid Metal Engineering Center, Canoga Park, CA (USA); Hanford Engineering Development Lab., Richland, WA (USA)). 1978. Contract EY-76-C-14-2170. 39p. (CONF-780308—8). Dep. NTIS, PC A03/MF A01.

From NACE meeting on corrosion; Houston, TX, USA (6 Mar 1978).

This paper reviews the interaction phenomena between sodium and reactor materials, and the application to reactor design and operation. Both corrosion and deposition are considered. Sodium removal and decontamination is briefly mentioned, together with some recent developments that are still in the experimental stage. No new theories of sodium-material interaction behavior are offered. 56 references.

637 (HEDL-SA—1425) **Flow impedance test results at HEDL: chemical basis.** Yunker, W. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1978. Contract EY-76-C-14-2170. 23p. (CONF-780677—6). Dep. NTIS, PC A02/MF A01.

From U.S. Japanese information exchange; Richland, WA, USA (Jun 1978).

In stainless steel liquid sodium heat transfer systems, the steel constituents undergo mass transfer. Transported material collects on the heat transfer surfaces in the form of films or crystals. The deposits usually are found in the cooler regions of the system where the temperature may be too low for significant diffusion of these elements into the base steel. Deposits which break free can add to the particulate inventory of the system. Materials reported included α-Fe, $NaCrO_2$, M_7C_3, $Cr_{23}C_6$, Mn and Cr_2C. The loss of material from the high temperature regions can result in a permanently roughened surface after extended periods of time, especially if the oxygen activity in the sodium has been high. The element silicon (1 w/o in stainless steel) has been ignored generally as being significant in mass transfer and sodium impurity control. The tests described show that, quite to the contrary, silicon is the cause of a number of flow, heat transfer and operational problems in such systems. Sodium tests have been run at HEDL to determine the cause of an apparent increase in friction factor which was observed during the testing of a 217-pin bundle in a 590°C isothermal sodium system.

638 (HEDL-SA—1432) **Sodium sampling and impurity monitoring systems in U.S. breeder reactors.** McCown, J.J.; Olson, W.H. (Hanford Engineering Development Lab., Richland, WA (USA)). 1978. Contract EY-76-C-14-2170. 30p. (CONF-780677—4). Dep. NTIS, PC A03/MF A01.

From U.S. Japanese information exchange; Richland, WA, USA (Jun 1978).

In the U.S. Breeder Reactor Program, sodium samplers and on-line impurity monitoring devices are used to provide complete sodium characterization data. The EBR-II has had such a program in place for over 10 years following the behavior of all detectable metals, non-metals and radionuclides. FFTF will be equipped with samplers and monitors which will be used to characterize all its sodium systems. This program will start in the summer of 1978 during sodium fill operations and continue for the life of the plant.

639 (HEDL-SA—1433) **Fuel failure monitoring systems in U.S. breeder reactors.** McCown, J.J.; Lambert, J.D.B. (Hanford Engineering Development Lab., Richland, WA (USA)). 1978. Contract EY-76-C-14-2170. 30p. (CONF-780677—3). Dep. NTIS, PC A03/MF A01.

From U.S. Japanese information exchange; Richland, WA, USA (Jun 1978).

In the U.S. Breeder Reactor Program, sodium cooled test reactors are equipped with systems for detecting, characterizing and locating fuel cladding breaches. Gas releases and sodium-fuel contact events are analyzed on EBR-II by continuous on-line cover gas and sodium monitoring techniques and by the laboratory analysis of periodic samples. On FFTF hardware, electronics and computer software required for FFM have been developed, designed and tested and are in place awaiting plant startup.

640 (HEDL-SA—1444) **Water vapor nitrogen process for removing sodium from LMFBR components.** Crippen, M.D.; Funk, C.W.; Lutton, J.M. (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1978. Contract EY-76-C-14-2170. 8p. (CONF-780232—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From IAEA meeting on sodium removal and decontamination; Richland, WA, USA (14 Feb 1978).

Application and operation of the Water Vapor-Nitrogen Process for removing sodium from LMFBR components is reviewed. Emphasis is placed on recent efforts to verify the technological bases of the process, to refine the values of process parameters, and to ensure the utility of the process for cleaning and requalifying components.

641 (HEDL-SA—1455) **Effects of irradiation creep on ex-reactor mechanical properties.** Duncan, D.R. (Hanford Engineering Development Lab., Richland, WA (USA)). May 1978. Contract EY-76-C-14-2170. 23p. (CONF-780722—6). Dep. NTIS (US Sales Only), PC A02/MF A01.

From 9. symposium on effects of radiation in structural materials; Richland, WA, USA (10 Jul 1978).

Irradiation creep of reactor components is usually considered nondamaging. This nondamaging concept has had no experimental verification; therefore, confidence in its application to reactor design is reduced. The damaging nature of irradiation creep was tested in the work described. Material used was SS-316 cladding of FFTF geometry, 5.84 mm x 5.08 mm, which had been irradiated under stress to provide significant amounts of irradiation creep. Specimens with no irradiation or stress exposure and specimens with zero stress irradiation exposure were used as controls. The actual test mode was a transient test, which imposes a constant internal stress on a closed piece of tubing and superimposes an increasing constant-rate temperature ramp on the tubing. The tests were conducted until failure occurred by tubing breach. Measured parameters were failure temperature and strain at failure. The effect of irradiation creep was monitored by comparing failure temperature and strain of specimens that had irradiation creep with failure parameters of specimens that had no irradiation creep. Results showed that specimens with irradiation creep failed at temperatures similar to those without irradiation creep. Strain results were less clear, but no major strain reductions were seen; thus, irradiation creep to the magnitudes investigated is nondamaging.

642 (HEDL-SA—1477) **FBR core design with the composite fuel assembly.** Cappiello, M.W. (Hanford Engineering Development Lab., Richland, WA (USA)). [nd]. Contract EY-76-C-14-2170. 18p. (CONF-780622—62). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; San Diego, CA, USA (18 Jun 1978).

Although calculations are preliminary, overall feasibility of an FBR core design with the composite fuel assembly has been demonstrated. The advantaged over the heterogeneous design is that large variances in assembly mixed mean outlet temperatures are eliminated. Also, the effective enrichment of an assembly may easily be adjusted by varying the number of fertile pins per assembly, thus making it possible to flatten the core radial power profile. The use of the composite fuel assembly may in the future offer a significant alternative to heterogeneous FBR core design.

643 (HEDL-TME—78-36) **Friction, wear, corrosion, and self-welding of Tribaloy 700 hardsurfacing in sodium.** Johnson, R.N.; Farwick, D.G. (Hanford Engineering Development Lab., Richland, WA (USA)). Jul 1978. Contract EY-76-C-14-2170. 83p. AT.

Tribalog 700 is a nickel-base hardsurfacing alloy that exhibits low friction, excellent wear resistance, and low corrosion rates in sodium; as such, it is well suited for use in high temperature liquid metal environments. Its freedom from cobalt makes it particularly attractive for nuclear applications. Tribaloy 700, rubbing against itself in sodium, exhibits among the lowest friction coefficients measured for metallic materials at high temperatures. In thermal cycling tests in sodium, detonation-gun coatings were unaffected by 120 cycles while all plasma coatings, except a special duplex coating, cracked or spalled within 30 cycles. Tribaloy 700 showed good resistance to self-welding at temperatures up to 540°C (1000°F) in sodium and at temperatures up to 315°C (600°F) in argon and sodium vapor. The physical properties of Tribaloy 700 are also described.

644 (ORNL—5286) **Nondestructive testing development program quarterly progress report for period ending March 31, 1977.** Hill, M.R. (Oak Ridge National Lab., TN (USA)). Jun 1977. Contract W-7405-ENG-26. 55p. AT.

Progress is reported for the following activities: (1) ultrasonic in-service inspection of EBR-II steam generator; (2) NDE support for departure nucleate boiling (DNB) test; (3) development of ultrasonic methods and equipment for LMFBR applications; (4) and advanced NDT development.

645 (ORNL/BRP/CD—78/6) **Clad/duct materials development. Technical status report for June 1978.** Rowcliffe, A.F. (Oak Ridge National Lab., TN (USA)). Jun 1978. Contract W-7405-ENG-26. 3p. AT.

The objective of the program is to identify and develop advanced alloys for cladding and duct use with improved resistance to swelling and to irradiation-induced mechanical property degradation. Information on stainless steel-316 and V-series alloys is presented.

646 (ORNL/TM—6413) **Molten-salt reactors for efficient nuclear fuel utilization without plutonium separation.** Engel, J.R.; Grimes, W.R.; Rhoades, W.A.; Dearing, J.F. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 52p. Dep. NTIS, PC A04/MF A01.

Research and development studies of molten-salt reactors (MSRs) for special purposes have been under way since 1947 and for possible application as possible commercial nuclear electric power generators since 1956. For the latter, the previous emphasis has been on breeding performance and low fissile inventory to help limit the demand on nonrenewable natural resources (uranium) in an expanding nuclear economy; little or no thought has been given to alternative uses of nuclear fuels such as proliferation of nuclear explosives. As a consequence, the conceptual designs that evolved (e.g., the ORNL reference design MSBR) all favored enriched ^{233}U as fuel with an on-site chemical processing facility from which portions of that fuel could be diverted fairly easily. With the current interest in limiting the proliferation potential of nuclear electric power systems, a redirected study of MSRs was undertaken in an effort to identify conceptual systems that would be attractive in this situation. It appears that practical proliferation-resistant MSRs could be designed and built, and the report describes a particularly attractive breakeven breeder that includes an on-site chemical reprocessing facility within the reactor primary containment.

647 (WARD-NA—3045-54) **Behavior of an iron manganese alloy as a monitor for carbon activity in liquid sodium.** Bagnall, C.; Shiels, S.A. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Jun 1978. Contract EY-76-C-02-3045-002. 27p. AT.

Owing to the shortcomings of a number of alloys previously selected for use as carbon activity monitoring materials in sodium systems, a need arose to investigate more fully the behavior of the remaining most promising candidate. Accordingly, DOE funding was provided to study an Fe-12Mn alloy, already identified as the reference material in the RDT Standard "Methods for the Analysis of Sodium and Cover Gas," (RDT-F-3-40T). Some concern had been raised as to the equilibration time and to the degree of response this alloy would have in both high and low carbon activity sodium environments. It was also important to determine how much manganese was lost during foil equilibration since this element has a direct influence on the carbon concentration established at a particular activity level. Four 200 hour tests were performed in an isothermal sodium test loop at 1300°F (704°C) under both carburizing and decarburizing conditions. The results showed that equilibrium was sufficiently established after 24 hours, although the ability of the Fe—Mn foil to carburize to significant levels was not demonstrated. Manganese depletion over a 200 hour period was significant. The surface concentration was lowered to 3-4 percent and the depth of depletion was about 0.8 mils. Several recommendations were made regarding the initial concentration of both manganese and carbon in the standard material, and to a limitation of the sodium exposure period. The need for additional evaluation was indicated.

648 (WARD-RB—3045-24) **Radial blanket design and development. Quarterly progress report for period ending February 28, 1978.** (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Jul 1978. Contract EY-76-C-02-3045-004. 92p. AT.

Progress is summarized in the following areas: radial blanket assembly heat transfer testing, radial blanket assembly irradiation, radial blanket flow orificing, and radial blanket rod bundle compaction tests. (DG)

649 (BNWL-tr—339) **Separation of radioactive impurities by the cold trap of the BOR-60 reactor.** Kizin, V.D.; Lisitsyn, E.S.; Poznyak, G.I.; Polyakov, V.I.; Chechetkin, Yu.V. Jul 1978. Translation of NIIAR-P-2, No. 296, 1977. 27p. Dep. NTIS, PC A03/MF A01.

The separation of radioactivity in the regular cold trap of the BOR-60 reactor was studied experimentally. It was shown that ^{65}Zn, ^{134}Cs, ^{136}Cs, ^{137}Cs, ^{131}I, ^{60}Co and ^{124}Sb accumulate in this trap. The sodium is purified almost completely of iodine in the cold trap, and the radioactivity of the cesium isotopes there amounts to 20-30% of their content in the primary loop. Experiments were carried out to determine the quantitative characteristics of the processes of separation of cesium from sodium by sorption on the sodium oxides and metal surfaces.

650 **Materials for fast breeder prototype reactor 'Monju'.** Kitagawa, H. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Kinzoku;* **47**: No. 6, 18-22(Jun 1977). (In Japanese).

The Power Reactor and Nuclear Fuel Development Corp. is forwarding the design of the fast breeder prototype reactor "Monju". The purposes of the development of Monju are to obtain the prospect on the performance, safety, reliability and operation of FBR power plants by the independent development and through the experiences of design, manufacture, construction and operation, in order to put FBRs in practical use in 1990s, and to develop and accumulate the international competitive power in the economy of future practical reactors. The general construction and the reactor core of this loop type 300 MWe plant are described. SUS 316 stainless steel is used for the handling head, upper shield, cladding tubes, entrance nozzle, and wrapper tube, and molybdenum-clad tantalum is considered as the lower shield in core fuel assemblies. In blanket fuel assemblies, the diameter of cladding tubes is different, and the lower shield is made of SUS 316. SUS 304 stainless steel is used for neutron shields, surveillance assemblies, and neutron sources. However, the wrapper tubes for the surveillance assemblies and neutron sources are made of SUS 316. SUS 316 or 304 is used for the most parts of control assemblies except the controlling material of B_4C. Trial manufacture, irradiation test and other tests are carried out to develop the materials for Monju.

651 **Materials for fast experimental reactor 'Joyo'.** Uematsu, K.; Noro, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Kinzoku;* **47**: No. 6, 13-17(Jun 1977). (In Japanese).

The fast breeder reactor "Joyo" is sodium-cooling type, and the mixed oxide of plutonium and uranium is used as the fuel. The purposes are to obtain the technological experience concerning fast breeder reactors through the design, construction and operation, and to utilize it for the irradiation test to develop materials and fuel. Joyo attained the criticality on April 24, 1977. The construction of Joyo, especially the elements composing the core, are described. As for the material of fuel assemblies, mostly stainless steel is used because the high-temperature strength is important under the operating condition of FBRs, the corrosion resistance is excellent in sodium, and the neutron absorption cross section is not serious with fast neutrons. The manufacturing technologies have been developed for cladding tubes, wrapper tubes, and end plugs. Also the inspection techniques have been developed, such as ultrasonic flaw detection and eddy current flaw detection. The high-temperature strength test and the irradiation test on cladding tubes were carried out. The specifications were established for cladding tubes and other parts as the results of trial manufacture, the development of inspection techniques, and various tests. The improvement of core design can be expected as the irradiation data on the materials used accumulate gradually.

652 (BNWL-tr—340) **Radioactivity of long-lived nuclides in the primary loop of the BOR-60 reactor during operation with defective fuel elements.** Gryazev, V.M.; Kizin, V.D.; Lisitsyn, E.S.; Polyakov, V.I.; Chechetkin, Yu.V. Jan 1977. Translation of NIIAR-P-5, No. 299, January 1977. 23p. Dep. NTIS, PC A02/MF A01.

Generalized measured results are presented on the accumulation and distribution of radioactive nuclides from corrosion and fission products during the four years of operation of the BOR-60, including fairly long operation with defective fuel elements in the core.

653 **Fast breeder of loop type liquid metal cooling system.** Nakai, Y.; Hoshi, Y. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1977-92,090/A/. 28 Jan 1976. 3p. (In Japanese).

The object of the invention is to locate an upper edge of a guard vessel of each apparatus in a primary liquid metal system lower than a system level to shorten an axial length of a primary circulating pump and to form each guard vessel into a smaller size. Upper portions of guard vessels for a reactor vessel, an intermediate heat exchanger and a primary circulating pump are disposed in position other than those in the vicinity of piping which forms a riser and are closed at a height lower than a system level, whereby a difference between the system level and an emergency level is reduced to shorten an axial length of a primary circulating pump.

654 **Fuel assembly.** Uesugi, N. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1977-89,795/A/. 23 Jan 1976. 4p. (In Japanese).

The object of the invention is to put a mark that may detect displacement in position between fuel assemblies to reduce error in signal. The device comprises a bundle of a plurality of fuel elements, a shroud which surrounds the outer peripheral surface of said bundle, a handling head positioned on said shroud, and discriminating marks and checking marks impressed on the upper end surface of said handling head, said discriminating marks having a single mark impressed to indicate a reference at the starting point thereof.

655 **Device for detecting radioactivity in a liquid metal coolant.** Miyazawa, T.; Kubo, K.; Taguchi, J. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1977-89,796/A/. 22 Jan 1976. 4p. (In Japanese).

The object of the invention is to considerably increase efficiency of neutron detection and at the same time, to facilitate maintenance and checking and to increase safety. A neutron detection system is provided in the outer periphery of a dual pipe line which extends upwardly from a cylinder type induction system magnet pump so that when a fissionable product is contained in the

flowing coolant, a neutron released from said fissionable product is detected by the neutron detection system. In this case, the neutron detection system is mounted so as to surround the dual pipe line portion and can detect most of neutrons released over the range of 360 degrees. Since the neutron detection system and a coil in the cylinder type induction magnet pump are insertably mounted in the outer periphery of the dual pipe line portion wherein the coolant is flown from an outer passage towards an inner passage in a part of a piping line through which coolant flows, they can be merely pulled out and new ones may be fitted, in case of replacement.

656 Fuel assembly. Takeda, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-89,794/A/. 21 Jan 1976. 5p. (In Japanese).

The object of the invention is to make a distribution of coolant flow in a radial direction and an azimuth direction within a core of a fuel assembly as flat as possible as the fuel burns. An orifice formed in a side of an entrance nozzle at the end of a shroud is designed to have an area which varies in the azimuth direction to decrease the coolant flow and capacity of pump.

657 Method of controlling the secondary coolant in FBR. Kajiyama, S.; Nakamura, A.; Watanabe, T. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-87,599/A/. 14 Jan 1976. 5p. (In Japanese).

The object of the invention is to stabilize and control flow rate without mutual interference by providing a closed-circuit flow control system for controlling the flow of secondary coolant to a superheater or a reheater, and a flow control system having an operator in which a relationship between the flow, opening degree of an adjusting valve and pressure is predetermined. A secondary coolant flow-signal detected by a detector and supplied from an intermediate heat exchanger to a first pipe line is fed into a ratio setting instrument, a second set signal obtained by a ratio of a first set signal is fed into an adjusting meter, a first adjusting valve is opened and closed on the basis of difference from the detection signal of the detector, the flow of secondary coolant branched into a second pipe line and supplied to the superheater is controlled in constant, a third set signal from the ratio setting instrument is fed into the operator to obtain a degree of valve opening, and a second adjusting valve is opened and closed to control in constant the flow of secondary coolant branched to a third pipe line and supplied to the reheater.

658 Reactivity meter. Rathod, N.C.; KHASNABIS, C.K.; PETHE, V.A. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). ELECTRONICS DIV.). pp 123-130 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

A reactivity meter developed on the basis of inverse kinetics is described. It analyses the dynamic response of a reactor to change in impressed reactivity and provides voltage output signal directly indicating reactivity on a linear scale. This type of reactivity meter is suitable for incorporating in reactor safety channels, particularly for fast reactor assemblies. Reactivity tests have been carried out on Apsara reactor and data on delayed neutron groups, fine rod positions and measured reactivity are presented.

REGULATION AND LICENSING

659 (INIS-mf—4178) **Use of on-site Project Officers by a nuclear regulatory body.** Beare, J.W. (Corporate Unverified). 1977. 8p. (CONF-7709126—). Dep. NTIS, PC A02/MF A01.

From Meeting on regulatory inspection practices in nuclear power plants; Madrid, Spain (20 Sep 1977).

660 (LTR—1310-22) **Electrical, instrumentation, and control codes and standards.** Kranning, A.N. (Idaho National Engineering Lab., Idaho Falls (USA)). 7 Jun 1978. Contract EY-76-C-07-1570. 28p. Dep. NTIS, PC A03/MF A01.

During recent years numerous documents in the form of codes and standards have been developed and published to provide design, fabrication and construction rules and criteria applicable to instrumentation, control and power distribution facilities for nuclear power plants. The contents of this LTR were prepared by NUS Corporation under Subcontract K5108 and provide a consolidated index and listing of the documents selected for their application to procurement of materials and design of modifications and new construction at the LOFT facility. These codes and standards should be applied together with the National Electrical Code, the ID Engineering Standards and LOFT Specifications to all LOFT instrument and electrical design activities.

661 (NUREG—0445) **Indexes to Commission issuances, October 8, 1956—January 18, 1975.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Administration). May 1978. 191p. NTIS $9.00.

The document contains digests and indexes for regulatory decisions of the Atomic Energy Commission and its hearing examiners rendered under the Atomic Energy Act of 1954 and published in ATOMIC ENERGY COMMISSION REPORTS, Volumes 1 through 8 covering 1956 through January 1975. Information elements common to the cases heard and ruled upon are (1) case names (owners of facility); (2) name of facility, docket number; (3) type of hearing (for construction permit, operating license, etc.); (4) issues raised by appellants; (5) issuance number; (6) type of issuance (memorandum, order, decision, etc.); (7) issuance pagination; (8) legal citations (cases, regulations, and statutes); and (9) subject matter of issues and/or rulings.

662 (NUREG/CR—0130(Vol.1)) **Technology, safety, and costs of decommissioning a reference pressurized water reactor power station.** Smith, R.I.; Konzek, G.J.; Kennedy, W.E. Jr. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 310p. Dep. NTIS, PC A14/MF A01.

Safety and cost information was developed for the conceptual decommissioning of a large [1175 MW(e)] pressurized water reactor (PWR) power station. Two approaches to decommissioning, Immediate Dismantlement and Safe Storage with Deferred Dismantlement, were studied to obtain comparisons between costs, occupational radiation doses, potential radiation dose to the public, and other safety impacts. Immediate Dismantlement was estimated to require about six years to complete, including two years of planning and preparation prior to final reactor shutdown, at a cost of $42 million, and accumulated occupational radiation dose, excluding transport operations, of about 1200 man-rem. Preparations for Safe Storage were estimated to require about three years to complete, including 1½ years for planning and preparation prior to final reactor shutdown, at a cost of $13 million and an accumulated occupational radiation dose of about 420 man-rem. The cost of continuing care during the Safe Storage period was estimated to be about $80 thousand annually. Accumulated occupational radiation dose during the Safe Storage period was estimated to range from about 10 man-rem for the first 10 years to about 14 man-rem after 30 years or more. The cost of decommissioning by Safe Storage with Deferred Dismantlement was estimated to be slightly higher than Immediate Dismantlement. Cost reductions resulting from reduced volumes of radioactive material for disposal, due to the decay of the radioactive containments during the deferment period, are offset by the accumulated costs of surveillance and maintenance during the Safe Storage period.

663 (NUREG/PRDI—78/7) **Power Reactor Docket Information.** (Nuclear Regulatory Commission, Washington, DC (USA)). Jul 1978. 91p. TIC $4.50.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission in support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name.

664 (NUREG/PRDI—78/8) **Power Reactor Docket Information.** (Nuclear Regulatory Commission, Washington, DC (USA)). Aug 1978. 106p. TIC $4.50.

Citations and subject indexing to the documentation associated with civilian nuclear power plants are presented. This material is that which is submitted to the U.S. Nuclear Regulatory Commission support of applications for construction and operating licenses. Citations are listed by Docket number in accession number sequence. The Table of Contents is arranged both by Docket number and by nuclear power plant name. (DG)

665 (RDT-STATUS—7-78) **RDT Standards. Status report.** (Department of Energy, Washington, DC (USA). Div. of Nuclear Power Development). Jul 1978. Contract W-7405-ENG-26. 26p. RSO.

Attached is the July 1978 Status Report of RDT Standards covering the period of April through June 1978.

666 Academy panel proposes new form of regional institution. Kloman, E.H. pp 19-27 of Executive conference on Energy Parks. La Grange Park, IL; American Nuclear Society (1977).

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, VA, USA (26 Apr 1977).

A panel of the National Academy of Public Administration has proposed development of a new form of interstate regional institution as an instrument for the siting, licensing, and regulating of nuclear facilities. Noting the danger that the nation's energy supplies may prove inadequate to meet basic needs of the economy despite increasing emphasis on greater use of coal and energy conservation, the panel pointed to the virtual stalemate in the national decision-

making process for siting and licensing nuclear plants. A basic cause of the logjam is the growing conflict and overlap between federal and state agencies for authorizing nuclear development. The panel recommended setting up a new form of regional organization to fill an institutional void between federal and state levels of government. The proposed regional organizations would be established through federal legislation preempting to the Federal Government the regulation of siting, licensing, and construction of nuclear facilities. They would have jurisdiction over all matters in the operation of nuclear plants relating to public health and safety including those environmental factors and socio-economic factors covered in the preparation of environmental impact statements.

ECONOMICS

REFER ALSO TO CITATION(S) 552, 553

667 (INIS-mf—4198, pp v) **Working group 1: Economic aspects. Main financial and economic problems required by the development of electricity district area during the period 1976-1985.** Maldague, R. (COMMISSARIAT AU PLAN, BELGIUM); FRERÖTTE, M. (ADMINISTRATION DE L'ENERGIE, BELGIUM). Mar 1976. (In French).

In Compilation of reports [prepared by various working groups on the evaluation of problems of utilizing nuclear energy in Belgium].

From three different G.N.P. growth rates models for the country the consumption of primary energy and electricity in 1985 and afterwards is evaluated following four models. The compared MWh cost of nuclear and classical power stations for electricity production evaluated for 1985 are analysed. The assumed power is 1300 MW for the nuclear and 600 MW for the classical power station. The power stations to install afterwards 1985 are presented and their impact on the financial investments, the employment and trade balance is considered.

668 (INIS-mf—4198, pp v) **Working group 3: Nuclear reactor types.** de MEESTER, P. (LOUVAIN UNIV. (BELGIUM)); PLANQUART, J.; STIENNON, G. (CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE, MOL (BELGIUM)). Mar 1976. (In French).

In Compilation of reports [prepared by various working groups on the evaluation of problems of utilizing nuclear energy in Belgium].

The technical and economic evaluation of the different types of reactors are presented as well as the comparative cost of the KWh from nuclear and classical sources for the year 1985. The outlook for the year 2000, the future of the fast and high temperature reactors, and the use of low temperature heat are considered.

669 (TID—28694) **Study of factors inhibiting effective use of domestic nuclear power.** (Department of Energy, Washington, DC (USA). Office of Energy Technology). 21 Feb 1978. 32p. Dep. NTIS, PC A03/MF A01.

The Administration's energy policy depends for its success on continued growth of the Nation's bulk power supply to meet the dual needs of continued industrial growth and reduced reliance on imported oil. New generating capacity, both coal and nuclear, will be needed to meet the demand. Although a large backlog of new plant construction still exists, which should result in significant new capacity being brought on line during the next few years, the sharp reduction in orders during the last 3 years, with the prospect of very few orders in 1978 and 1979, leads to serious concern over the Nation's ability to bring new capacity on line five or more years from now. Furthermore, plants under construction and in the licensing process are being delayed, and costs are escalating for these as well as potential new plants. These trends, if they continue, could have major adverse impact on the cost of electricity, and manufactured products, to the American consumer. The following growth-inhibiting factors are examined: (1) uncertainty over government acceptance of nuclear power, (2) long and uncertain lead times, (3) financing difficulties, (4) fuel cycle problems, (5) fuel supply concerns, (6) lack of standardization, (7) conflicting base load projections, (8) public relations, (9) fuel and waste transportation, and (10) lack of government support for resolution of Technical problems. (DG)

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 65, 552, 553

670 (CONF-770893—) **Low temperature nuclear heat.** Kotakorpi, J.; Tarjanne, R. (comps.). (Finnish Nuclear Society; European Nuclear Society, Petit-Lancy (Switzerland); American Nuclear Society, Chicago, IL). Aug 1977. 604p. Dep. NTIS (US Sales Only), PC A99/MF A01.

From Meeting on low temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The meeting was concerned with the use of low grade nuclear heat for district heating, desalination, process heat, and agriculture and aquaculture. The sessions covered applications and demand, heat sources, and economics.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

671 (DLR-FB—77-16, pp 7-18) **Double-P/sub N/ approximation of the neutron transport equation in slab geometry in consideration of linear-anisotropic scattering.** Bartsch, G.; HAUPTMANNS, U. (TECHNISCHE UNIV. BERLIN (GERMANY, F.R.). INST. FUER KERNTECHNIK). 1977. (In German).

In Contributions to the transport phenomena in fluid mechanics and related fields.

In this work extrapolation distances, collision probabilities, angular fluxes, flux ratios, and critical dimensions are calculated for one dimensional reactor problems in slab geometry using the Double-Psub(N)-Method. The influence of linearly anisotropic scattering and in special cases that of a spatially constant neutron source on these characteristic parameters is investigated.

672 (ORNL/TM—6078) **COVERT and CAVALIER: two computer codes for estimating uncertainties of calculated neutronics parameters using standard interface files SENPRO and COVERX.** Drischler, J.D.; Marable, J.H.; Weisbin, C.R. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

A description is given of the computer code CAVALIER, which provides a simple means for estimating the uncertainties in calculated neutronics parameters that result from uncertainties in nuclear data. This code uses predetermined detailed multigroup sensitivity coefficients in SENPRO format for specific reactor and/or shielding assemblies and multigroup cross-section covariance uncertainties in COVERX format. Also described is the computer code COVERT, which converts unformatted (binary) covariance files to card image form and vice versa. This is useful for transferring covariance files from one installation to another. These two codes, along with extended compilations of sensitivity coefficients and covariance matrix libraries are currently available through the Radiation Shielding Information Center (RSIC) at Oak Ridge National Laboratory.

673 (TUBIK—56) **Introduction to nuclear reactor technology.** Hauptmanns, U. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Kerntechnik). Apr 1977. 159p. (In Spain). ZAED.

An introduction to reactor technology is given with emphasis on reactor physics. The technological aspects are touched upon in various places and treated more thorougly in one specific case, that of the reactor pressure vessel. Extensive remarks concerning the present discussion on nuclear energy aim at placing the material presented in a more general and societal context.

674 **Calculation of errors of approximation and restoration of energy distribution in a reactor.** Plekhanov, L.P. *At. Energ. (USSR);* **42**: No. 4, 268-271(Apr 1977). (In Russian).

A method to estimate the accuracy of approximating neutron flux with a functional system and restoring the flux using discrete measurements is proposed. The method is based on a limited character of variations of non-controllable parameters governing the neutron field. The estimations obtained may be used in both error analysis and deciding an approximating functional system as well as number and arrangement of neutron detectors. As a paragon, the one-group neutron diffusion equation of an infinite cylindrical reactor in a steady state is considered.

675 **Contributions to the kinetics of the multiregion reactors.** Lazarescu, G. (Institutul de Fizica Atomica, Bucharest (Romania)). *Stud. Cercet. Fiz.;* **28**: No. 9, 895-920(1976). (In Romanian).

One proposes a theoretical description improvement of the multiregion reactors kinetic conduct and a systematic experimental study of the kinetic parameters of a bizonal coupled reactor, using the neutrons pulsated source method. Taking into account the power characteristics of the coupling neutrons, two new models of the propagation function are proposed. For the first time, values of the coupling coefficient for sub-critical configuration of Argonaut bizonal coupled reactor are obtained. The comparison between calculated and experimental values gives a very good agreement.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 801, 1072, 1078

676 (BMFT-FB-K—77-10) **Standard and prototype tests of hotwater- and steam-valves for nuclear power stations.** Dernbach, B. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Nov 1977. 40p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

More than 150 standard and prototype valves have been tested in a special valve test facility (VTF) for reactor valve tests under working conditions. Approximately 85% of the valves performed well for the given task, in some cases however only after numerous improvements jointly done with the manufactures; 15% turned out to be unserviceable.

677 **Handling of steam drain in nuclear power plants.** Pal, S.; BHATTACHARYA, B. (DEVELOPMENT CONSULTANTS LTD). pp 235-246 of Symposium on operating experience of nuclear reactors and power plants. Bombay; Department of Atomic Energy (1977).

From Symposium on operating experience of nuclear reactors and power plants; Bombay, India (7 Feb 1977).

Compared to thermal power plants, steam flow rate in nuclear power station currently being installed in the India is large. Steam condition at the turbine inlet is moist to the extent of 0.26%. Thus, while the requirement of steam draining in thermal power plant is basically during start-up and the flow quantity is comparatively small, draining of steam lines in nuclear power plants is a regular feature during operation and it involves handling a larger quantity of drain. Experiences gained while handling steam drains in nuclear power plants are presented. Problems of inadequate and inefficient collection and disposal of such drains, which may lead to serious problems such as damage to turbine blading due to water ingress, etc. are outlined.

678 (DLR-FB—77-16, pp 289-296) **Investigations of cavitation phenomena in pumps and pipes with resonance detectors.** Wesser, U.; KLOCKGETHTER, J. (TECHNISCHE UNIV. BERLIN (GERMANY, F.R.). INST. FUER KERNTECHNIK). 1977. (In German).

In Contributions to the transport phenomena in fluid mechanics and related fields.

In fluid flows with high acoustic noise level resonance detectors are applied to measure cavitation phenomena for example in pumps. The analysis of the acoustic signals associated with the collapse of transient cavities leads to statistical parameters characterizing the cavitation state in the flow. The method is applicable even in the state of incipient cavitation. Some results for pumps and pipes are reported.

679 **Area neutron monitors.** Bapat, S.D.; VAGHELA, M.G. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). ELECTRONICS DIV.). pp 16-21 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

An area neutron monitor suitable for neutron flux measurement in reactors is described. The monitor consists of a BF_3 counter with audible and visual alarms with the required electronic circuits using such monitors. Neutron fields at different locations can be monitored from a central console. Calibration of indoor and outdoor responses are given.

680 **Self powered neutron detectors.** Gopalan, C.S.; RAMACHANDRA RAO, M.N.; INGALE, A.D. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). ELECTRONICS DIV.). pp 131-137 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

Two types of self powered neutron detectors used for in-core flux measurements are described. The characteristics of the various detectors, with emitters Rh, V, Co, Py are presented. Details about the fabrication of these detectors are given.

681 **Development and applications of isotope radiography in the manufacture of high pressure boilers and nuclear components.** Baskaran, S.; PANDALA, S.K. (BHARAT HEAVY ELECTRICALS LTD., TIRUCHIRAPALLI (INDIA)). pp 25-30 of Proceedings of the national symposium on industrial isotope radiography. Bombay; Department of Atomic Energy (1977).

From National symposium on industrial isotope radiography; Tiruchirapalli, India (26 Feb 1976).

The use of isotope radiography in the manufacture of high pressure boilers and other nuclear components is discussed. The different types of cameras and sources to suit the needs and change in technologies are described in brief. Use of isotopes in the examination of steel-castings, boiler drum welds and other speciality applications are dealt with. The need for a regional centre of the Isotope Division of the Bhabha Atomic Research Centre, Bombay, to cater to the industries' requirements is emphasised.

682 **On-line monitor for measuring heavy water and tritium release through ventilation exhaust of a nuclear reactor.** Natarajan, K.; GORE, A.R. (DEPARTMENT OF ATOMIC ENERGY, BOMBAY (INDIA). POWER PROJECTS ENGINEERING DIV.). pp 34-42 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

A conceptual design of an on-line system for measuring the quantities of heavy water and tritium released through ventilation system of an operating heavy water power reactor is described. The tritium bubbler technique which makes it possible to estimate the leakage of heavy water through the ventilation air and the heavy water isotopic measurement technique using infrared beam are explained. The integrated system incorporates alarm circuits to give contact outputs when the D_2O loss rate or the tritium release rate is high. Details of calculations and design parameters are given. The sensitivities claimed in the prototype using a infrared analyser for D_2O concentration measurement and a small volume tritium-in-water flow cell are 30 ppm and 1 nano curie/ml respectively.

683 (Juel—1437) **Investigation on flow and heat transfer for in-line banks of tubes with pyramidal roughness.** Groehn, H.G.; SCHOLZ, F. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Jul 1977. 25p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

Integral values of heat transfer and pressure drop are reported. They have been gained from 5 tube banks in cross flow of different tube pitches and roughnesses. The experiments were conducted at Reynolds number $5 \cdot 10^3 < Re < 10^6$ with air and helium as experimental fluid on the outside of the tubes. Increasing artificially the roughness of the tubes, a gain in heat transfer was achieved up to 50% compared to a tube arrangement of technically smooth tubes without increasing the flow resistance. Besides this the fraction of each tube row of the integral heat transfer coefficient of the bundle was measured. In comparison to an arrangement of smooth tubes the heat transfer of the first tube row was increased in relation to the following ones. Furthermore the artificial roughness of the tubes effected an equalisation of the velocity profiles behind the heat exchanger.

684 (KFK—2426) **Direct numerical simulation of turbulent velocity-, pressure- and temperature-fields in channel flows.** Goetzbach, G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Oct 1977. 199p. (In German). Dep. NTIS (US Sales Only), PC A10/MF A01.

Thesis.

For the simulation of non stationary, three-dimensional, turbulent flow- and temperature-fields in channel flows with constant properties a method is presented which is based on a finite difference scheme of the complete conservation equations for mass, momentum and enthalpy. The fluxes of momentum and heat within the grid cells are described by sub-grid scale models. The sub-grid scale model for momentum introduced here is for the first time applicable to small Reynolds-numbers, rather coarse grids, and channels with space dependent roughness distributions.

685 **Microstructural instabilities during creep of 9%Cr—1%Mo steel.** Sanderson, S.J. (AERE Harwell, Engl). *Met. Sci.;* **21**: No. 4, 220-222(Apr 1978).

This note concerns a steel with a composition (wt.-%) of 0.10 C, 0.75 Si, 0.52 Mn, 9.02 Cr, 1.02 Mo, 0.27 Ni, 0.022 P, 0.002 S, 0.019 N, balance Fe, which had received heat treatments intended to simulate the structures encountered in thin-section components following high temperature fabrication. The intense interaction of dislocations with the fine precipitates produced during the creep testing of normalized samples results in low minimum creep rates in contrast to the higher minimum creep rates allowed by the coarser, tempered structure.

686 **Quality control aspects in radiography of nuclear equipment.** Chandrachoodan, P.P. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). CENTRAL WORKSHOPS). pp 38-50 of Proceedings of the national symposium on industrial isotope radiography. Bombay; Department of Atomic Energy (1977).

From National symposium on industrial isotope radiography; Tiruchirapalli, India (26 Feb 1976).

The in-service inspection and repair work, in case of a breakdown, in a nuclear power plant poses problems owing to the extremely high radiation field. In order to bring down the incidence

of breakdown, efficient quality control methods in combination with rigid acceptance standards are resorted to at the different stages of manufacture. Various non-destructive methods of examination are employed in this regard. Radiography is one of these methods which is widely utilized. The salient features of the radiographic process followed in the quality control programme in the manufacture of nuclear equipment is discussed.

687 Device for cooling and controlling a reactor container. Kawaguchi, O. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-90,797/A/. 23 Jan 1976. 3p. (In Japanese).

The object of the invention is to incorporate a gas cooling device arranged within a reactor container into an existing air substitution system to thereby effectively cool the container and to readily perform installation work of machineries and equipments. Normally, a reactor container when plant is in operation is filled with N_2 gases supplied from a liquid nitrogen evaporation device through piping. The N_2 gases are heated by a pressure vessel or the like in a reactor and guided exteriorly of the container through piping into which an isolating valve is inserted, cooled by a cooling coil in an air conditioner, pass through piping in an air conditioning system through a duct with assistance of a blower, and again introduced into the container. In case of personal spot inspection, the valve is opened to introduce air into the container.

688 Fuel exchanging device. Imada, T. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1977-85,694/A/. 12 Jan 1976. 4p. (In Japanese).

The object of the invention is too stop oscillation of a telescope mast, which results from fuel movement, immediately after stopping of movement thereof, to permit operation of fixing-device to be effected easily thus performing operation of fuel exchange in a short period of time. A closed member composed of a soft film, which is subjected to expansion and contraction by pouring-in and out of fluid, is provided between a telescope mast, which is provided with a fuel gripper and supported on a fuel exchanging device body through a spherical thrust bearing, and an annular secured member secured to said fuel exchanging device body and surrounding said telescope mast. In this arrangement, after movement of the telescope mast has been stopped, the fluid is poured into said closed body to expand said closed body thereby stopping the oscillation of the telescope mast.

689 Alarm meters and relays for nuclear power station. Deo, P.M.; SETH, K.K.; PREMCHANDRAN, T. (DEPARTMENT OF ATOMIC ENERGY, BOMBAY (INDIA). POWER PROJECTS ENGINEERING DIV.). pp 96-107 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

The indicating type of alarm instruments known as alarm meters and the blind type of alarm instruments known as alarm relays, used in reactors, are described. The relative advantages of the two types are mentioned. The reliability of different alarm meters and relays, their positions in reactors and their functions are mentioned with reference to the power reactors being set up at Kalpakkam.

690 On-line fine impulse testing of protection instrumentation systems for nuclear power plants. Ron, V.H.; DAS, M.K. (ELECTRONICS CORP. OF INDIA, HYDERABAD). pp 7-12 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

The various kinds of faults that are likely to occur in a reactor system and on-line testing methods developed to protect the reactor system are outlined. The test circuit is described.

691 Symposium ON NUCLEAR REACTOR INSTRUMENTATION [HELD AT] BOMBAY [DURING] DECEMBER 20-23, 1976(PAPERS]. VOL. 1. SECT. 1. REACTOR INSTRUMENTATION. Bombay; Department of Atomic Energy (1976). vp. (CONF-761264—P1).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

Separate abstracts for individual papers presented at the conference on reactor instrumentation are included.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 1132

692 (CONF-780742—1) **Summary of methods used in rod-bundle thermal-hydraulic analyses.** Sha, W.T. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 23p. Dep. NTIS, PC A02/MF A01.

From Turbulent forces convection in channels and rod bundles; Istanbul, Turkey (20 Jul 1978).

Three pertinent methods used in rod-bundle thermal-hydraulic analysis are summarized. These methods are: (1) subchannel analysis, (2) porosity and distributed resistance approach, and (3) benchmark rod-bundle thermal-hydraulic analysis using boundary fitted coordinate system. Assumptions employed and shortcomings in each of these methods are clearly delineated.

693 (KFK—2345) **Out-of-pile-experiments on ballooning of zircaloy fuel rod claddings. Test results with shortened fuel rod simulators.** Wiehr, K.; SCHMIDT, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit). Oct 1977. 14p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

Ballonning experiments were performed on shortened indirectly heated fuel for simulators in an air atmosphere. The test set-up and the test procedure are described. The following results were achieved: 1) initial internal rod pressures of 70 bar result in burst circumferential strains of about 36%, higher internal pressures in lower strains: 2) the measured strain rates and temperatures are characteristic of the normal plastic behaviour of zircaloy-4: 3) initial eccentricities between the pellet stack and the cladding initiate differential circumferential temperatures up to 100 K at rupture: 4) in case of pronounced differential circumferential temperatures the rupture point is always located on the hot surface line which, in most cases, is a straight or partly concave line with high local strain, i.e., maximum weakening of the wall thickness: and 5) the hot surface line is not lifted off the heat source, whereas the opposite colder side is, but without any measurable reduction in wall thickness.

694 Pressure excursion in compacted UO_2 fuel elements at a reactor's first bringing into power. Samsonov, B.V.; Sulaberidze, V.Sh. *At. Energ. (USSR);* **42**: No. 4, 277-279(Apr 1977). (In Russian).

Results of measuring pressure in experimental uranium dioxide fuel elements in stainless steel cladding during the first hours of power operation are presented. As the reactor power is raised, the pressure increases due to desorption of process gas from the fuel surface. The amount of released gas depends on the atmosphere filling the fuel element; when filled with helium or air, it is equal to 2 x 10^{-8} m^3/kg UO_2. The gas release becomes noticeable at an average bulk temperature of 1050-1250 K. During reactor operation at nominal power level, the released gas is again absorbed. This process is described by the regularities of a heterogeneous chemical reaction with diffusion kinetics.

695 Supporting structure for fuel pins. Hirama, H.; Fujisaki, H. (to Daini Seikosha Co. Ltd., Tokyo (Japan)). Japanese Patent 1977-92,089/A/. 29 Jan 1976. 3p. (In Japanese).

The object of the invention is to axially provide two slits intersecting a lower end plug for fuel pins and to form with external threads in outer periphery thereof so that they may be engaged or disengaged with meshes of a supporting frame to install and remove the fuel pins accurately and independently. After slits in the lower end plug have been inserted in intersection of meshed longitudinal and lateral plates, a nut is engaged on external threads to secure the fuel pins to the frame.

CONTROL SYSTEMS

696 Power control of the Dodewaard power reactor by application of the 'neutron poison' gadolinium. Termaat, K.P. (Keuring van Electrotechnische Materialen N.V., Arnhem (Netherlands)). *Neftegazov. Geol. Geofiz.;* **44**: No. 1, 38-42(Mar 1978). (In Dutch).

The nuclear power reactor at Dodewaard (Netherlands) was reset to a cycle of 12 months instead of 10 months. This was achieved by raising the degree of enrichment of the fissionable material from 2.5 to 2.8%. For improved control the neutron absorber Gd_2O_3 is added to the fuel together with a change in the control rod configuration. Computations of the multiplication factor and fission rate for the new situation are presented. The results for the production are discussed.

697 Test result for the control rod drive mechanism in sodium for prototype LMFBR 'Monju'. Ishii, Y.; Murakami, Y. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). *Doryokuro Giho;* No. 22, 69-84(May 1977). (In Japanese).

The Japanese prototype LMFBR (liquid metal fast breeder reactor) "Monju" has nine rough control rods, three fine control rods, four safety rods and three back-up stopping rods, nineteen rods in total. These control rods must have very high reliability for the function of regulating reactivity, scramming, etc.. The Power Reactor and Nuclear Fuel Development Corporation ordered in 1971 the

manufacture of three control rod drive mechanisms, the design of which was a little different each other, and these were tested in water first, then tested in sodium at the "Oarai Engineering Center" one by one. About 500 times of scram test, and 10000 to 100000 times of driving test in full stroke and about 50 mm eccentric condition were carried out. These test results were very satisfactory, consequently second step of trial manufacture was conducted by reflecting the results of the tests and modifying the mock-ups. The arrangement of control rods in the core of "Monju", the functions of each rod, the design specification of the mock-ups of this mechanism, the structural design, the test facility in sodium, the test results, the characteristic evaluation and the feedback of these results to the design of the "Monju" mechanism are explained in this paper.

698 Philosophy of the power distribution computer-controlled system for channel type reactors. Emel'yanov, I.Ya.; Filipchuk, E.V.; Potapenko, P.T.; Dunaev, V.G.; Kuznetsov, N.A. *At. Energ. (USSR);* **42**: No. 4, 263-267(Apr 1977). (In Russian).

Basic principles of creating a computerized system for optimal control of shim rod locations in the core of a channel type reactor are formulated. Reactor nominal power, in-core axial power distribution and initial locations of the control rods serve inputting data to the system. The control algorithm is drawn using the least square method to minimize (with certain technological limitations) deviations of a power distribution from an averaged one. The mathematical description of the process is based on the static matrix-model reactor. The limitations, given as inequalities, are taken into account by mathematical modelling of the systems response to limiting values of the controlling inputs.

699 Optimal relationship between components of emergency protection actuator operating time. Petrov, V.P. *At. Energ. (USSR);* **42**: No. 4, 259-262(Apr 1977). (In Russian).

Minimization of safety rod actuator operating time is studied. The rods are held out of the core by electromagnets and springs are used to insert them. An optimal relationship is derived between start-up time of the holding electromagnets and motion time of safety rods. Two basic variants of safety rod motion are considered: in a gaseous and a liquid medium. Minimum operating time of the actuator is found to occur if the start-up time of the electromagnets equals half the motion time of the safety rods.

700 Control rod for a fast breeder. Saito, T.; Yamagishi, Y.; Koga, T. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1977-87,598/A/. 16 Jan 1976. 3p. (In Japanese).

The object of the invention is to dispose a stopper, which is destroyed when a reactor power increases, at an upper part within a shroud and to place a neutron absorber on the stopper so as to constitute a reactor stopping system which is simple in construction and high in accuracy. When the reactor power increases as a result of failure, fissionable material or a stopper whose melting point is the limit temperature at the core is destroyed and a neutron absorber moves down within the shroud until it comes into contact with a cushion material by means of a spring for the scramming operation.

701 Method and device for controlling reactor power. Tanabe, A.; Takigawa, Y. (Nippon Atomic Industry Group Co. Ltd., Tokyo). (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1977-87,4597/A/. 13 Jan 1976. 5p. (In Japanese).

The object of the invention is to automatically prevent shifting of a reactor in a running condition at high power into an abnormal running condition in the vicinity of natural circulation of coolant, thereby preventing the core stability and channel stability from being worsened. In a reactor under the power running condition, when the forced circulation force of recycling flow of coolant is decreased to a level in the neighbourhood of natural circulation flow, said running condition is detected to insert a neutron absorber into the reactor whereby the reactor power may be automatically controlled to a level lower than a fixed value. At this time, since the reactor power can be reduced to a level lower than a fixed value by the automatic operation, there occurs no possible personal observation error by each operator.

702 Control rod drives. Shirakawa, T. (to Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). Japanese Patent 1977-84,393/A/. 6 Jan 1976. 5p. (In Japanese).

The object of the invention is to moderate driving of a control rod, when the latter is removed, to prevent a rapid increase in local power and a fuel failure resulting therefrom. A housing is extended outside a pressure vessel in a reactor, and a control rod is coupled through an index tube to one end of a main piston which is disposed within the housing and is moved by working fluid pressure selectively imparted to opposite end surfaces thereof. The index tube is axially formed with a plurality of stepped portions so that the latter may always engage a latch. Further, the housing has a brake device, which utilizes a friction or magnetic repulsing force, said brake device restricting movement of the index tube integral with the control rod to reduce a speed of removing the control rod.

703 Electronic power demand unit for reactor regulating system. Pandey, U.N.; NATARAJAN, K. (DEPARTMENT OF ATOMIC ENERGY, BOMBAY (INDIA). POWER PROJECTS ENGINEERING DIV.). pp 168-177 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

An electronic power demand unit for the reactor regulating system of the Rajasthan Atomic Power Station is described. The performance of the unit, based on limited tests, is found to be satisfactory.

704 RAPS reactor regulating system performance. Sharma, M.P. (RAJASTHAN ATOMIC POWER STATION, KOTA (INDIA)). pp 142-145 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

The reactor regulating system of the Rajasthan Atomic Power Station reactors is designed to control reactor power between 10^{-7} of full power to 110% of full power and to raise or lower power of controlled rates manually between these limits. Triplicated instrumentation is used. The performance of system is discussed. The problems faced and methods and means adopted to overcome them are enumerated.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 1398

705 (NUREG/CR—0227) Model plutonium recycle reactors for environmental analysis of the mixed-oxide fuel cycle. Wachter, J.W. (Oak Ridge National Lab., TN (USA)). 30 Jun 1978. Contract W-7405-ENG-26. 50p. (ORNL/NUREG—21). Dep. NTIS, PC A03/MF A01.

Model plutonium-recycle reactors have been defined for use in calculating the radionuclide content of light water reactors fueled both with rods containing enriched-uranium oxide and with rods containing mixed-oxide (MOX) fuel. The mixed-oxide fuel is a blend of recycle plutonium dioxide and natural uranium dioxide. The model reactor contains first-, second-, and third-recycle plutonium in a proportion defined by a reactor management mode in which the mixed-oxide content of the reactor is always at least 15 percent greater than that of a similar reactor utilizing only its self-produced plutonium. The ORIGEN isotope generation and depletion computer code was employed to calculate the maximum radionuclide content of the fuel within the reactor in the event of an accident and to calculate the radioactivity of the spent fuel. These results have been compared with similar calculations using enriched-uranium model reactors to provide data that have been used in the GESMO Study for comparison of the potential environmental hazards of enriched-uranium reactors with those of plutonium-recycle reactors.

706 Atoms-for-Peace: an uncertain future. Hansen, O. pp 6-14 of Executive conference on Energy Parks. La Grange Park, IL; American Nuclear Society (1977).

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, VA, USA (26 Apr 1977).

The United States was the originator and a principal architect of Atoms-for-Peace. In his address to the United Nations General Assembly on December 8, 1953, President Eisenhower proposed a "way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life." He called for the creation of a new international agency and for the pooling of materials and technology to enhance the peaceful uses of atomic energy. The United States has contributed more than any other country to make this dream a reality. Today, the need to apply these same principles to assure mankind the peaceful benefits of the atom and to avoid nuclear war is more urgent than ever before. Now, however, Atoms-for-Peace may be a casualty of changing the U.S. nuclear policies. To place current developments in perspective, a brief review of the evolution of the program is presented.

707 Nuclear program and site selection. An ecological standpoint. Billen, G. *Rev. Phys. Appl.;* **32**: No. 9, 143-149(1976). (In French).

The author considers the problem related to the environment in a highly industrialized country like Belgium, in the scope of the conclusions of the "sages report". He analyses the impact on the ecosystem of the gaseous fission product release from nuclear facilities, the aspects of different type of cooling systems for the nuclear

power plants as well as transport cost of energy, the size of the power plants, the energetic policy and the economic activities.

708 Possibility of reactor startup without an auxiliary neutron source with particular reference to FBTR. Paranjape, S.R.; SANGODKAR, D.B.; PANDURANGAN, K. (REACTOR RESEARCH CENTRE, KALPAKKAM (INDIA)). pp 1-6 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

An analysis of the countrates obtainable with the intrinsic source of the fast breeder test reactor at Kalpakkam is presented and its adequacy for the first start-up as well as for any subsequent routine start-up is discussed. The available detector locations are indicated. It is concluded that the intrinsic source strength and detector-core geometry in FBTR can permit the first approach to criticality as well as any subsequent routine start-up being achieved without an auxiliary neutron source.

SITING

709 (INIS-mf—4198, pp v) **Working group 4a: Regional aspects. Nuclear power plants siting in the dutch speaking part of the country.** Willems, M. (RIJKSUNIVERSITAIR CENTRUM TE ANTWERPEN (BELGIUM)); MEDART, R. (MINISTERE DES AFFAIRES ECONOMIQUES, BRUSSELS (BELGIUM). LAB. CENTRAL); VANNESTE, O. (WESTVLAAMSE EKONOMISCHE RAAD). Mar 1976. (In French).

In Compilation of reports [prepared by various working groups on the evaluation of problems of utilizing nuclear energy in Belgium].

The problems due to nuclear plant siting in the northern region of Belgium are reviewed with an emphasis on economical, environmental and esthetical aspects. Three types of sitings were analysed: inland, coastal and off-shore. For the in-land siting, Doel, where already two units are in operation (780 MW(e)) and a third in construction (900 MW(e)), is supposed to be able to receive a fourth unit of 1000 MW(e). The coastal siting is practically impossible for two reasons: the lack of cooling water when a coastal inland region of 5 km is considered and the strong density of tourists on the 66 km coast. For artificial island siting the different aspects are considered: type of soil, marine environment, construction factors, security, construction time, costs, etc. A comparative study for 9 off-shore sites is presented.

710 (INIS-mf—4198, pp v) **Working group 4b: Regional aspects. Siting in Walloon region and offshore.** Wilmes, PH. (LOUVAIN UNIV. (BELGIUM)); FINCOEUR, P.; SLEGERS, G. (CONSEIL ECONOMIQUE REGIONAL DE WALLONIE). Mar 1976. (In French).

In Compilation of reports [prepared by various working groups on the evaluation of problems of utilizing nuclear energy in Belgium].

Four nuclear power plant solutions in view of siting have been considered: a) saturation of the existing sites; b) creation of new sites only for the production of electrical power and/or thermal energy; c) creation of complete sites for the transformation of nuclear materials; and d) off-shore power plant siting and the creation of an artificial island.

711 Executive conference on Energy Parks. Executive conference proceedings. La Grange Park, IL; American Nuclear Society (1977). 132p. (CONF-770441—).

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, VA, USA (26 Apr 1977).

Portions of document are illegible.

Included are six papers. Each paper has been separately processed for the Energy Data Base.

712 Political authorities of local government. Messing, M. pp 50-62 of Executive conference on Energy Parks. La Grange Park, IL; American Nuclear Society (1977).

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, VA, USA (26 Apr 1977).

Historically the responsibility for planning, siting, constructing, and operating the generating, transmission, and distribution systems for electric utility service (as well as the end-use systems) developed within the electric utility industry itself, subject to state and local regulation. This responsibility was later sanctioned as a functional authority as both private and publicly-owned utility franchises were negotiated with states and brought under the regulatory purview of Public Service Commissions and Public Utility Commissions around the turn of the century. Since 1970 this historic framework has been substantially altered by the enactment of powerplant siting laws in approximately 23 states and by the assertion of state interests in not only the corporate regulation, but the long range planning of electric powerplants and the consideration of alternative energy systems. Thus it is instructive to consider the authorities for powerplant siting in the following context: (1) historically the reponsibility and the authority for powerplant siting has redounded to franchised utility companies; (2) since 1970 the states have begun to exercise their constitutional authority over the development of power plant siting and energy systems; (3) both local governments and electric utility companies exist as subdivisions of the state, subject to state regulation and the delegation of state authorities. However, the assertion of state authorities in this area has come at a time when changes in the technology an the institutional structure of the electric utility industry have extended the functional service areas beyond the geographic boundaries and political jurisdictions of either local or state government, thereby creating a jurisdictional hiatus between the serivce areas of electric utilities and the jurisdictional authorities of state and local government.

713 Hanford Nuclear Energy Center study: some observations. Harty, H. pp 65-80 of Executive conference on Energy Parks. La Grange Park, IL; American Nuclear Society (1977).

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, VA, USA (26 Apr 1977).

Major findings of the HNEC study to date are as follows: (1) No insurmountable technical problems have been revealed, but problems have been identified that appear to be more difficult to resolve than those for dispersed siting. (2) Major technical advancements are needed in meteorology and probably in seismology before an ER or SAR can be prepared for an NEC. (3) The absence of licensing guidelines and criteria appears to be one major deterrent to utility action in developing an NEC. (4) NECs will probably bring about the use of dry or wet-dry cooling systems before they are required in equivalent numbers for dispersed plants. (5) Utilities appear to favor a satellite-type NEC rather than a major concentration of nuclear facilities at a single location. (6) The NEC concept may not be as conserving of total energy as dispersed facilities may be in the future.

714 Potential energy center site investigations. Savage, W.F. (Energy Research and Development Administration, Washington, DC). pp 81-85 of Executive conference on Energy Parks. La Grange Park, IL; American Nuclear Society (1977).

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, VA, USA (26 Apr 1977).

Past studies by the AEC, NRC, NSF and others have indicated that energy centers have certain advantages over dispersed siting. There is the need, however, to investigate such areas as possible weather modifications due to major heat releases, possible changes in Federal/state/local laws and institutional arrangements to facilitate implementation of energy centers, and to assess methods of easing social and economic pressures on a surrounding community due to center construction. All of these areas are under study by ERDA, but there remains the major requirement for the study of a potential site to yield a true assessment of the energy center concept. In this regard the Division of Nuclear Research and Applications of ERDA is supporting studies by the Southern and Western Interstate Nuclear Boards to establish state and utility interest in the concept and to carry out screening studies of possible sites. After selection of a final site for center study , an analysis will be made of the center including technical areas such as heat dissipation methods, water resource management, transmission methods, construction methods and schedules, co-located fuel cycle facilities, possible mix of reactor types, etc. Additionally, studies of safeguards, the interaction of all effected entities in the siting, construction, licensing and regulation of a center, labor force considerations in terms of local impact, social and economic changes, and financing of a center will be conducted. It is estimated that the potential site study will require approximately two years.

715 Nuclear energy centers: a utility's view. Moskovitz, D.H.; Rossin, A.D. pp 121-129 of Executive conference on Energy Parks. La Grange Park, IL; American Nuclear Society (1977).

From American Nuclear Society executive seminar on nuclear energy centers; Arlington, VA, USA (26 Apr 1977).

The concept of energy parks in general and nuclear energy centers in particular has received consideration by utility and government planners since the early 1960's. Reaction to the approach have varied widely. Utilities, however, have generally responded favorably to the principle but recognize that only a very few such sites would be identified and not all of these would be developed. Brief comments on the energy center concept are divided into three general areas: (1) potential problems associated with licensing and other environmental reviews; (2) Commonwealth Edison's assessment of the energy center concept and the near term potential for such sites in the midwest; and (3) several suggested actions which appear prerequisite to the establishment of energy parks.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 607

716 (BNWL-SA—6302) **Speciation studies of radionuclides in low level wastes and process waters from pressurized water reactor.** Abel, K.H.; Robertson, D.E.; Crecelius, E.A.; Silker, W.B. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1977. Contract EY-76-C-06-1830. 7p. (CONF-771113—14). Dep. NTIS, MF A01.

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

Portions of document are illegible.

Physicochemical characterization studies of aqueous process streams at San Onofre Generating Station Unit No. 1 are providing important source term information concerning the forms of radionuclides being released into the marine environment. The primary coolant, secondary steam condensate, processed low level wastes and tertiary coolant were sampled at several different times in the nuclear fuel cycle. Rdionuclides were partitioned into particulate, cationic, anionic, and nonionic species in the reactor process streams, and into particulate and soluble species in the tertiary seawater coolant. Characterization of the particulate species has included a detailed size distribution. The purpose of this research was to provide information concerning chemical and physical forms of the radionuclides being released to the coastal zone from a nuclear generating station in order to facilitate design of radiobiological studies necessary for assessment of their environmental significance.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 638, 639, 641, 644, 660, 749, 750, 751, 754, 785

717 (AAEC/E—428) **Measurement of the dynamic response of the materials testing reactor HIFAR.** Harries, J.R.; WILSON, D.J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1978. 38p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Power transients were initiated in the HIFAR Materials Testing Reactor by altering both the temperature of the primary coolant circuit and the flow rate of the primary coolant. Analysis of the time variation of the reactor power and the D_2O temperature provided information about the flow of D_2O in the reactor aluminium tank and the time response of the negative power coefficient. The experimental power transients were compared with calculations carried out with the HIDYN code, which combines the neutron kinetics with the primary coolant characteristics.

718 (AAEC/E—435) **Analysis of self-terminating power transients in the reactor HIFAR.** Connolly, J.W.; FURGUSON, H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1978. 19p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The consequences of step reactivity additions above critical have been calculated for HIFAR under conditions of no coolant flow and the operating coolant flow rate of 400 kg s^{-1}. In particlar, the maximum core excess reactivity that will allow loss of a central coarse control arm blade from the core has been determined. In order to perform these calculations a cylindrical geometry version of the neutron kinetics, heat transfer code ZAPP has been written and tested against the experimental data from the SPERT III-E oxide core. The results of this comparison are given as an appendix to the report.

719 (HEDL-SA—1333) **Testing of FFTF fuel handling equipment.** Coleman, D.W.; Grazzini, E.D.; Hill, L.F. (Energy Research and Development Administration, Washington, DC (USA); Westinghouse Hanford Co., Richland, WA (USA)). Jul 1977. Contract EY-76-C-14-2170. 43p. (CONF-771120—24). Dep. NTIS, PC A03/MF A01.

From Winter annual meeting of the American Society of Mechanical Engineers; Atlanta, GA, USA (27 Nov 1977).

The Fast Flux Test Facility has several manual/computer controlled fuel handling machines which are exposed to severe environments during plant operation but still must operate reliably when called upon for reactor refueling. The test programs for two such machines—the Closed Loop Ex-Vessel Machine and the In-Vessel Handling Machine—are described. The discussion centers on those areas where design corrections or equipment repairs substantiated the benefits of a test program prior to plant operation.

720 (HEDL-SA—1354-FP) **Inelastic analysis of pipeline in FFTF heat transport system.** Chen, W.L.; Weiner, E.O. (Hanford Engineering Development Lab., Richland, WA (USA)). Dec 1977. Contract EY-76-C-14-2170. 27p. (CONF-780609—15). Dep. NTIS, PC A03/MF A01.

From ASME/CSME pressure vessels and piping conference; Montreal, Canada (25 Jun 1978).

The detailed inelastic (elastic-plastic-creep) analysis is presented for the Primary Crossover Pipe Line in the Fast Flux Test Facility (FFTF), subjected to the combined deadweight and thermal loads. It demonstrates the inelastic structural responses of the complete pipe run and satisfaction of ASME Code requirements at elevated temperatures. The analytical tool used for this analysis is the general purpose nonlinear finite element program, MARCCDC. The pipe line is modeled using the combinations of closed section beam elements and 3-node elbow elements. Results of creep relaxation under multiaxial loading of the piping systems are compared with those of uniaxial loading in a simple two-bar model. Creep-fatigue damage evaluations are calculated by following the procedures of ASME Code Case 1331-5.

721 (HEDL-SA—1485) **Irradiation test program for FFTF.** Corrigan, D.C.; Last, G.A. (Hanford Engineering Development Lab., Richland, WA (USA)). [nd]. Contract EY-76-C-14-2170. 10p. (CONF-780622—63). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; San Diego, CA, USA (18 Jun 1978).

Four unique deisgn features are described which make the Fast Flux Test Facility eminently suitable for irradiation test programs. These features are a fast flux level of 7 x 10^{15} neutrons/cm^2/sec, a 36-inch reference (breeder reactor) core height, test volumes suitable for testing of statistical quantities of materials, and the capability for direct (contact) or indirect (proximity) instrumentation of active core experiments.

722 (HEDL-SA—1504-FP) **Experimental confirmation of the design to minimize vibration and wear in 61-pin wire-spaced EBR-II subassemblies.** Fukuda, S.K. (Hanford Engineering Development Lab., Richland, WA (USA)). May 1978. Contract EY-76-C-14-2170. 5p. (CONF-780622—71). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; San Diego, CA, USA (18 Jun 1978).

Examinations of HEDL 61-pin subassemblies comprised of 5.84 mm (0.230) inch diameter mixed-oxide fuel pins with 1.02 mm (0.040") diameter spacer wire (PNL-9, -10, -11, HEDL-N-E, -N-F), showed severe cladding and spacer wire wear after irradiation in EBR-II. A comparison of a large number of design, fabrication, and irradiation parameters for all of the HEDL subassemblies indicated that the porosity per ring of fuel pins correlated significantly with the occurrence of wear on the fuel pins. The porosity per ring is the clearance between the flat-to-flat pin bundle dimension and the inner hex can dimension divided by the number of hexagonal fuel pin rings in the subassembly. The porosity per ring for PNL-9, -10, -11 and HEDL-N-E was 0.15 mm/ring (6 mils/ring) and 0.18 mm/ring (7 mils/ring) for the HEDL-N-F subassembly. Since the original FTR subassembly design had a porosity/ring spread of 0.04 mm/ring to 0.16 mm/ring (1.67 to 6.11 mils/ring) an additional series of irradiation tests was conducted to confirm that a tighter fuel pin bundle would eliminate the wear.

723 (HEDL-SA—1517) **Sodium vapor deposits observed at HEDL on large components.** Funk, C.W.; Eichelberger, R.L. (Hanford Engineering Development Lab., Richland, WA (USA); Atomics International Div., Canoga Park, CA (USA)). [nd]. Contract EY-76-C-14-2170. 18p. (CONF-780677—5). Dep. NTIS, PC A02/MF A01.

From U.S. Japanese information exchange; Richland, WA, USA (Jun 1978).

Testing of the Fast Flux Test Facility (FFTF) components in the High Temperature Sodium Facility (HTSF) has provided operating experience with sodium vapor deposits prior to reactor operation. Large component testing in liquid sodium at temperatures up to 1100°F (593°C) has simulated the thermal operating conditions of the FFTF including the evaporation rate of sodium from the surfaces of high temperature sodium. Testing of several plant scale components with various reactor head plug gap configurations has made it possible to evaluate the influence of annuli gap clearance on sodium vapor deposits. The dimensions of the annuli are described, followed by details of the operating conditions of their exposure to sodium vapor and observations of the amount and character of vapor deposits.

724 (HEDL-TME—78-13) **Mechanical behavior of fast reactor fuel pin cladding subjected to simulated overpower transients.** Johnson, G.D.; Hunter, C.W. (Hanford Engineering Development Lab., Richland, WA (USA)). Jun 1978. Contract EY-76-C-14-2170. 195p. Dep. NTIS, PC A09/MF A01.

Cladding mechanical property data for analysis and prediction of fuel pin transient behavior were obtained under experimental conditions in which the temperature ramps of reactor transients were simulated. All cladding specimens were 20% CW Type 316 stainless steel and were cut from EBR-II irradiated fuel pins. It was determined that irradiation degraded the cladding ductility and failure strength. Specimens that had been adjacent to the fuel exhibited the poorest properties. Correlations were developed to describe the

effect of neutron fluence on the mechanical behavior of the cladding. Metallographic examinations were conducted to characterize the failure mode and to establish the nature of internal and external surface corrosion. Various mechanisms for the fuel adjacency effect were examined and results for helium concentration profiles were presented. Results from the simulated transient tests were compared with TREAT test results.

725 (HEDL-TME—78-51) **Ductility and strength of FFTF/CRBRP structural materials irradiated in various spectra. Interim report.** Ward, A.L.; Blackburn, L.D. (Hanford Engineering Development Lab., Richland, WA (USA)). Aug 1978. Contract EY-76-C-14-2170. 76p. AT.

Tension test results have been obtained for the initial half of the FFTF/CRBRP Structural Materials Irradiation Experiment which was designed to investigate in EBR-II the relatively low temperature (659 to 676°K) effects of neutron fluence (to 6.4 x 10^{22} n/cm^2) interpretation of behavioral and spectrum (average neutron energies from 0.19 to 0.77 MeV) on the strength and ductility of 304 SS, 316 SS, weld-deposited 308L SS and Alloy 718. An interim (fluences of 1.9 x 10^{22} n/cm^2) interpretation of behavioral trends in these materials as they relate to fluence limits for out-of-core FBR component applications indicates that, by comparison, the energy-independent fluence limits for 0.10 residual tensile elongation currently in use for CRBRP are conservative for the stainless steel materials.

726 **General purpose gamma monitor.** Bendre, R.J.; KALE, S.W. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). ELECTRONICS DIV.). pp 6-9 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

A gross gamma monitor based on scintillation technique is incorporated as a process instrument in R-5 reactor for monitoring gamma activity in the coolant loop. The system is designed with a minimum number of active components so as to achieve high reliability. Full advantage of gain characteristics of the photomultiplier is taken and thereby use of any temperature sensitive log element is eliminated. The principle of operation is explained. The performance of the meter is discussed.

727 **Multirange monitor for R-5 and new method of parameter display.** Pethe, V.A.; PATANKAR, A.A.; CHAGANTY, S.P. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). ELECTRONICS DIV.). pp 108-114 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

An improved method to monitor currents of the order of 10^{-10} amp, using the log-antilog technique in d.c. amplifiers is described. This monitor has been tested and is intended to be used in the Trombay R-5 reactor.

728 (KFK—2498) **Experimental determination of local heat flux variation in an electrically heated BR-2 rod.** Meyer, L.; MERSCHROTH, F. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Aug 1977. 18p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The installation of thermocouples within the cladding of an electrically heated BR-2 rod might cause local variations of heat flux. In order to detect a resulting temperature variation at the outer surface, experiments with a single electrically heated rod with heat fluxes up to 30.80 W/cm^2 and heat transfer coefficients up to 1000 W/m^{2}K by forced convection in air were conducted. The surface temperatures were measured with an optical pyrometer. The experiment showed about 0.6% variation in the surface temperature. An analysis with the TAC2D-code shows that local variation in the heat flux under these conditions is less than 1.2%.

729 (LTR—111-107) **Comparison of LOFT zero power physics testing measurement results with predicted values.** Rushton, B.L.; Howe, T.M. (Idaho National Engineering Lab., Idaho Falls (USA)). 26 Jun 1978. Contract EY-76-C-07-1570. 28p. (RE-P—78-055). Dep. NTIS, PC A03/MF A01.

The results of zero power physics testing measurements in LOFT have been evaluated to assess the adequacy of the physics data used in the safety analyses performed for the LOFT FSAR and Technical Specifications. Comparisons of measured data with computed data were made for control rod worths, temperature coefficients, boron worths, and pressure coefficients. Measured boron concentrations at exact critical points were compared with predicted concentrations. Based on these comparisons, the reactivity parameter values used in the LOFT safety analyses were assessed for conservatism.

730 (LTR—113-51) **Core-power and decay-time limits for disabled automatic-actuation of LOFT ECCS.** Hanson, G.H. (Idaho National Engineering Lab., Idaho Falls (USA)). 5 Jun 1978. Contract EY-76-C-07-1570. 16p. (RE-A—78-103). Dep. NTIS, PC A02/MF A01.

The Emergency Core Cooling System (ECCS) for the LOFT reactor may need to be disabled for modifications or repairs of hardware or instrumentation or for component testing during periods when the reactor system is hot and pressurized, or it may be desirable to enable the ECCS to be disabled without the necessity of cooling down and depressurizing the reactor. LTR 113-47 has shown that the LOFT ECCS can be safely bypassed or disabled when the total core power does not exceed 25 kW. A modified policy involves disabling the automatic actuation of the LOFT ECCS, but still retaining the manual activation capability. Disabling of the automatic actuation can be safely utilized, without subjecting the fuel cladding to unacceptable temperatures, when the LOFT power decays to 70 kW; this power level permits a maximum delay of 20 minutes following a LOCA for the manual actuation of ECCS.

731 (LTR—114-90) **Technical Specification Figure 3-1, PCS temperature vs. pressure.** Brown, E.S. (Idaho National Engineering Lab., Idaho Falls (USA)). 6 Jun 1978. Contract EY-76-C-07-1570. 13p. Dep. NTIS, PC A02/MF A01.

The bases and procedure for plotting LOFT Technical Specification Figure 3-1, PCS Temperature vs. Pressure is presented. The curves define fracture toughness limits for the carbon steel vessels (Reactor vessel, pressurizer and steam generator) in the primary coolant system (PCS). An allowance is included for the lag between measured fluid temperature and metal temperature of the carbon steel components for the heat up situation. As a result the curves are conservative for the cooldown situation. However, no allowances for expected pressure and temperature instrument errors is included in the curves.

732 (LTR—115-41) **Sensitivity study of main steam flow control valve closing and opening times.** Tylee, J.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Mar 1978. Contract EY-76-C-07-1570. 29p. Dep. NTIS, PC A03/MF A01.

The sensitivity of the LOFT plant to different main steamflow control valve closure and opening times is examined using a hybrid computer simulation. Results for seven valve opening rates and seven valve closing rates are presented and discussed. Comparisons are made between this analysis and the current FSAR which assumes a 20 second full stroke motion rate. While full-stroke valve motion times of 1 to 40 seconds are shown to be acceptable with respect to safety margins, a motion time of 10 to 30 seconds is recommended to allow for adequate control sensitivity.

733 (LTR—1118-1) **Dry scram evaluation.** (Idaho National Engineering Lab., Idaho Falls (USA)). 6 Jun 1978. Contract EY-76-C-07-1570. 7p. Dep. NTIS, MF A01.

Portions of document are illegible.

The analysis performed by Todd Shipyards concerning the ability of the LOFT CRDMs to withstand a dry scram is presented. A "dry scram" could result in the CRDM components yielding; however, it would probably not render the CRDMs inoperable. It also concluded that a dry scram is highly unlikely based on a typical LOFT depressurization curve and the temperature of the fluid in the upper pressure housing. At the time of scram, the fluid in the upper pressure housing will not flash to steam owing to the pressure-temperature relationship existing during the scram cycle.

734 (LTR—1119-33) **Preliminary analysis of LOFT Reactor vessel closure. Addendum I, Volume I. Appendix A-3.** (MPR Associates, Inc., Washington, DC (USA)). Nov 1970. Contract EY-76-C-07-1570. 75p. (MPR—239). Dep. NTIS, PC A04/MF A01.

The purpose of this analysis is to determine if the two piece flat head closure concept presently being considered by INC for the LOFT reactor vessel will meet the structural and fatigue requirements of Article 4 of Section III, "Nuclear Vessels," of the ASME Boiler and Pressure Vessel Code, for the anticipated LOFT operational requirements. The analyses performed include stress analyses based on classical stress analysis methods and proven computer programs, fatigue analyses based on the fatigue criteria of Section III of the Code, and thermal analyses based on multi-dimensional computer programs.

735 **Experiment with the pneumatic carrier facility at CIRUS.** Jayaprakash, N.K. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). REACTOR OPERATIONS DIV.). pp 199-202 of Symposium on operating experience of nuclear reactors and power plants. Bombay; Department of Atomic Energy (1977).

From Symposium on operating experience of nuclear reactors and power plants; Bombay, India (7 Feb 1977).

For radiotracer studies using short lived products of neutron radiation as tracer, it is necessary that the transit time from completion of irradiation to availability to the researcher be kept as low as possible, of the order of a few seconds. This is achieved by transporting the sample contained in a capsule pneumatically from the fume hood in the laboratory to the reactor core and return it back to the laboratory station after the irradiation. Experiences with such a pneumatic carrier facility at Cirus, India are reported. Modification being carried out in the design are also indicated.

736 Nondestructive burn-up verification of EK-10 fuel, by Ge(Li) gamma-ray spectrometry. Ursu, I.; Farcasiu, O.M.; Stanescu, S.P.; Dumitrescu, R. (Institutul de Fizica Atomica, Bucharest (Romania)); Rodean, E.; Ionescu, V. (Comitetul de Stat pentru Energia Nucleara, Bucharest (Romania)). *Rev. Roum. Phys.;* 21: No. 6, 627-631(1976).

A method of using the gamma-ray intensity ratios ^{13}H7Cs(661.6 kev)/H1H3H4Cs(604.7 kev) coupled with H1H3H7Cs(661.6 kev)/^{144}Pr(696.5 kev) and the ratio ^{137}Cs(661.6 kev)/^{154}Eu(723.3 kev) for the burn-up determination of EK-10 type irradiated fuel elements having a great variety of cooling times is presented.

737 Effect of time constants of neutron detection channels on control of PURNIMA reactor. Das, S.; SRINIVASAN, M. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). NEUTRON PHYSICS SECTION). pp 146-155 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

A kinetic calculation is carried out to evaluate the exact role of time constants of neutron detection channels on the protection capability of nuclear instrumentation in the PURNIMA reactor. Reactivity insertion rates considered ranged from 2 cent/sec to 20 $/sec. Six groups of delayed neutrons corresponding to fast fission of ^{239}Pu were used. The time constants of the neutron control channels as a function of power level, the calculated electronic delays in neutronic channels the sum of electronic and nuclear delays and the protection capability for various settings are summarised and presented in tables.

738 Detection and location of failed fuel in fast reactors. Sangodkar, D.B. (REACTOR RESEARCH CENTRE, KALPAKKAM (INDIA)). pp 13-17 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

The methods adopted for detection of failed fuel elements in the fast breeder test reactor at Kalpakkam viz. the delayed neutron detection method (DND) and the gaseous fission product detection method (GFPD) are described. Various methods employed for locating the failed fuel in fast reactors are summarised. The gas-tagging method is briefly discussed.

739 Development of neutron detectors and nuclear instrument channels for FBTR. Sangodkar, D.B.; PARAMASIVAN, C. (REACTOR RESEARCH CENTRE, KALPAKKAM (INDIA)); RATHOD, N.C. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA)). pp 41-45 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

Factors which have been taken into account in the design of neutron detectors in the instrument system of the fast breeder test reactor at Kalpakkam (India) are mentioned. The development program is briefly described.

740 Campbell channel for R-5. Pethe, V.A.; PATANKAR, A.A.; CHAGANTY, S.P.; RAO, D.R.K. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). ELECTRONICS DIV.). pp 115-122 of Symposium on nuclear reactor instrumentation. Vol. I. Bombay; Department of Atomic Energy (1976).

From Symposium on nuclear reactor instrumentation; Bombay, India (20 Dec 1976).

The Campbell technique, a statistical method, avoiding conventional d.c. channel and its associated problems like drift, low current measurement etc. is very advantageous for incore flux measurements. The main advantage of compbelling is the gamma discrimination. The system electronics as used in Trombay R-5 reactor is described.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

REFER ALSO TO CITATION(S) 790, 791, 792, 793

741 (HWS—6670) **Specification [for] mechanical installation for river water pump house Building No. 181-N. 100-N Project CAI-816.** (Burns and Roe, Inc., New York (USA)). 1960. Contract EY-76-C-06-1857. 128p. Dep. NTIS, PC A07/MF A01.

Portions of document are illegible.

This specification covers the furnishing of certain specified materials and equipment and the provision of all labor, supervision, supplies, equipment and special tools required for the handling, installation and readying for operation of all the equipment described.

742 (RL-NRD—423) **Reference data: 109-N auxiliary piping systems.** Bainard, W.D. (General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation). 15 Jul 1965. Contract EY-76-C-06-1857. 19p. Dep. NTIS, MF A01.

Portions of document are illegible.

Specification HWS-6899, "Mechanical Installation for Heat Exchanger Building—Building No. 109-N," has 199 pages. Two Addendums and eighteen Amendments have been issued. Descriptions, system conditions, and material specifications are listed for 58 auxiliary piping systems in 109-N. In designing changes or additions to some of these systems, considerable time has been spent in the past sorting through HWS-6899 and its changes to determine design conditions and materials for the system being modified. This information has been compiled for future reference to save time and reduce the chance of error.

743 (UNI—661) **Evaluation of N fuels boiling subchannel flow and DNB behavior.** Cohn, P.D.; Peistrup, P.E. (United Nuclear Industries, Inc., Richland, WA (USA)). 19 Sep 1977. Contract EY-76-C-06-1857. 13p. Dep. NTIS, PC A02/MF A01.

An updated evaluation of the boiling and burnout performance of the N Reactor fuels is presented. Several new procedures and improvements for fuel analyses are described. These include the following items incorporated into the BOTHER computer program: subroutine FLOBAL which balances the flows among the boiling and nonboiling channels to equilibrate pressure drop; a new enthalpy imbalance factor for the MKIV fuel of 19.4% (95/95 basis); an updated method for calculating the two-phase pressure drop multiplier for each channel type, which includes both momentum and friction terms; and changes in the BOTHER code. The net effect of these changes is to predict DNBR limits before connecter boiling and at slightly higher flows and lower tube powers than predicted previously.

744 (UNI—663) **Primary pump suction pressure limits.** Shoemaker, R.H. (United Nuclear Industries, Inc., Richland, WA (USA)). 19 May 1978. Contract EY-76-C-06-1857. 10p. Dep. NTIS, PC A02/MF A01.

In conjunction with the operational testing program which was carried out prior to the startup of N Reactor, a study was carried out to establish limits for suction pressure of the primary (reactor coolant) pumps. The purpose of the report is to document the results of the study and interpret them with respect to the current mode of reactor operation.

745 (UNI—696-2) **Operation of K-N electrical power supply in parallel with B bus turbine generator. Final report for Production Test N-418.** Thorson, W.R.; Loudagin, R.L. (United Nuclear Industries, Inc., Richland, WA (USA)). 10 Feb 1978. Contract EY-76-C-06-1857. 17p. Dep. NTIS, PC A02/MF A01.

The K-N 13.8 kV electrical intertie line was designed to provide an independent offsite power source which could be operated in parallel with B Bus turbine generator (T-G). When the K-N line is operated in parallel with the T-G, a separation of the two power systems by bus tie breaker opening presents a sudden increase in load on the T-G and a subsequent increase in the steam load requirements to supply the T-G. Production Test N-418 was authorized for the testing of steam transient load response capabilities for the Foster Wheeler steam boiler, the two Combustion Engineering steam boilers, and for the reactor secondary steam system. This final report provides data and evaluation of test results performed by steam transient loading as authorized by PT-N-418.

746 (UNI—707-2) **Final report for PT N-419. Load testing of K-N electrical power supply.** (United Nuclear Industries, Inc., Richland, WA (USA)). 10 Feb 1978. Contract EY-76-C-06-1857. 7p. Dep. NTIS, PC A02/MF A01.

The K-N 13.8 kV electrical tie line was designed and constructed to provide for a reliable and independent offsite power source to be used as a power source for N Plant operations. The 13.8 kV transmission line was designed to be capable of supplying all of

N Plant power requirements and to successfully start a CRW 3500 hp river pump with normal loads on the line. Production Test N-419 was authorized to test the K-N 13.8 kV power source for carrying a minimum of 8 MVA load and to concurrently start a CRW motor. The report provides test data documentation and summarizes results of load testing of the K-N electrical power source as authorized by Production Test N-419.

747 (UNI—842) **NUSAR backup calculations for the control rod and ball systems.** Moffitt, R.L. (United Nuclear Industries, Inc., Richland, WA (USA)). 1 Jun 1978. Contract EY-76-C-06-1857. 23p. Dep. NTIS, PC A02/MF A01.

The analytical models and methods used in determining the exposure dependent rod and ball system strengths, and maximum rod and ball channel worths for the NUSAR are described. The rod and ball system strengths are shown. The maximum rod channel worths for one through seven rod channels out of service are presented. The maximum ball channel worths for one through seven ball channels out of service, for the samarium and boron ball systems, are also presented. These results were obtained using the computer code EXTERMINATOR-II.

748 (UNI-NUSAR—391-B) **N Plant life factors, January 1978 update.** Alexander, W.K.; Kratzer, W.K.; Schmidt, J.P. (United Nuclear Industries, Inc., Richland, WA (USA)). 10 Feb 1978. Contract EY-76-C-06-1857. 46p. Dep. NTIS, PC A03/MF A01.

In May, 1975, ERDA-RL requested a review of factors which could limit the useful life of N-Reactor as a basis for determining the feasibility of extended plant operation. It was concluded from the review that no known conditions existed which would limit the operability of N-Reactor before 1985, and most likely for several years beyond 1985. ERDA-RL also retained consultants to provide an independent review of N-Reactor plant life factors. Consulting teams from Oak Ridge National Laboratories, North Carolina State University and Battelle Northwest supported the conclusions of United Nuclear Industries, Inc. N-Plant life was again reviewed by UNI in December 1976 and the earlier conclusions were substantiated. Since 1976, additional experience has been obtained which provides increased confidence that life limiting factors should not be encountered until the 1990's. The purpose of the report is to provide an updating of the conclusions reached in 1975 and 1976 on N-Reactor plant life considerations. Data obtained since the December 1976 review are incorporated and significant items are highlighted.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 662, 1378, 1906, 2134

749 (ANL-RDP—70) **Reactor development program. Progress report, April 1978.** (Argonne National Lab., IL (USA)). 16 Jun 1978. Contract W-31-109-ENG-38. 186p. AT.

The report summarizes work in the following research and development areas: Experimental Breeder Reactor No. II (EBR-II), Breeder-Reactor Design Support, Instrumentation and Control, Reactor Physics, Reactor Safety, and GCFR Type Reactors.

750 (ANL-RDP—71) **Reactor development program. Progress report, May 1978.** Sachs, R.G.; Kyger, J.A. (Argonne National Lab., IL (USA)). 12 Jul 1978. Contract W-31-109-ENG-38. 165p. AT.

Progress is summarized in the following research and development areas: Experimental Breeder Reactor No. II (EBR-II), breeder-reactor design support, instrumentation and control, reactor physics, reactor safety, energy and environmental systems, and gas-cooled fast breeder reactors.

751 (ANL-RDP—72) **Reactor development program. Progess report, June 1978.** (Argonne National Lab., IL (USA)). 11 Aug 1978. Contract W-31-109-ENG-38. 200p. AT.

The report summarizes work performed in the following research and development areas: Experimental Breeder Reactor No. II (EBR-II), Breeder-Reactor Design Support, Instrumentation and Control, Reactor Physics, Reactor Safety, and Gas Cooled Fast Breeder Reactors.

752 **Use of mobile remote-handling equipment in connection with nuclear accidents.** Vertut, J. (CEA CENTRE D'ETUDES NUCLEAIRES DE SACLAY, 91 - GIF-SUR-YVETTE (FRANCE)); KISSEL, PH.P. (CEA CENTRE D'ETUDES NUCLEAIRES DE FONTENAY-AUX-ROSES, 92 (FRANCE). DEPT. DE PROTECTION). pp 123-147 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977). (In French)

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

In the event of a nuclear accident it will be necessary to start operations as soon as possible in zones inaccessible to man in order to determine the nature and extent of damage (measurement of various parameters, visual observation and photography) and to take action with a view to limiting the consequences of the accident. These various operations will have to be performed by remote-handling equipment containing measurement devices, television cameras and manipulators. The development of devices for immediate action is not independent of that of devices for subsequent operations either for repair or for dismantling. The paper describes the devices used at present in France and reports the experience gained over several years by the CEA Mobile Remote-Handling Team during action at nuclear facilities. It suggests a strategy for the utilization of such equipment and outlines a programme for developing essential facilities, taking into account the possibilities of international assistance.

753 (BMFT-FB-K—77-09) **Cooling behavior of a pressurized water reactor-core after loss of coolant accident during the refill of the core by the emergency cooling system.** Schneider, D.; THOMAS, E. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Nov 1977. 72p. (In German). Dep. NTIS (US Sales Only), PC A14/MF A01.

The heat transfer during the refill-phase of the core after LOCA was investigated experimentally by reflooding tests on an internally flowed single tube. The hydraulic diameter was corresponding to a subchannel of the PWR-core, the heat capacity of the fuel material was simulated by ceramic material. Besides the measuring technique and the experimental technique of single tube tests, first results were achieved on the influence of flood-rate, initial tube temperature and pressure on the flooding process.

754 (BNL-NUREG—24141-R) **Containment response to postulated core meltdown accidents in the Fast Flux Test Facility.** Gasser, R.D.; Pratt, W.T. (Brookhaven National Lab., Upton, NY (USA)). Aug 1978. Contract EY-76-C-02-0016. 100p. Dep. NTIS, PC A05/MF A01.

An assessment of the containment margin available in the Fast Flux Test Facility to mitigate the consequences of a postulated failure on in-vessel post-accident heat removal following a hypothetical core-disruptive accident (HCDA) has been completed. Two general meltdown configurations (termed in-vessel and ex-vessel) have been considered, and it is concluded that: (1) For the in-vessel meltdown scenario, the quantity of sodium assumed ejected from the vessel into the cavity during the HCDA is crucial to the subsequent reactor containment building (RCB) pressurization. If the reactor cavity liner is also assumed to fail, then the containment integrity could be challenged within 10 hours. (2) For the ex-vessel meltdown scenario, the collapse of the reactor cavity floor, which allows sodium to contact the unlined subcavity, is crucial to the subsequent RCB pressurization. Predictions of cavity floor penetration vary between 2 to 60 hours depending on the initial assumptions made; however, after floor collapse occurs overpressurization of the RCB occurs rapidly within several hours.

755 (BNL-NUREG—24532) **Hydrogen release rates from corrosion of zinc and aluminum.** van Rooyen, D. (Brookhaven National Lab., Upton, NY (USA)). May 1978. Contract EY-76-C-02-0016. 44p. Dep. NTIS, PC A03/MF A01.

In the unlikely event of a loss of coolant accident (LOCA) in a nuclear power plant, it would be necessary to avoid the complication of excessive hydrogen build-up in the containment. The size of recombiners needed to assist in controlling hydrogen accumulation depends in part on temperature-rate relationships of metal-water or metal-steam reactions such as: $Zn + 2H_2O = Zn(OH)_2 + H_2$ or $2Al + 3H_2O = Al_2O_3 + 3H_2$. The metals are present as coatings, such as galvanizing or metal-rich paints used to protect steel used within the containment. In the normal course of events, these metal surfaces would corrode at negligible rates in the atmosphere, and H_2 release would be minimal, since they are exposed only to the air present in this part of the plant. In the case of a LOCA, high temperatures (up to 150°C) combined with high H_2O contents could prevail for various times, and safety spray systems would introduce aqueous sodium borate solutions at a pH of about 9 (PWR) or neutral water (BWR). In order to obtain bases for estimating corrosion rates, we have to rely on laboratory test data, since no actual field experience is available or likely to be in the near future. This report summarizes the work of several laboratories, and includes additional analyses of their data.

756 (CONF-780819—13) **Agglomeration characteristics of fast reactor HCDA aerosols.** Parker, G.W.; Creek, G.E.; Sutton, A.L. Jr. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

The behavior of vaporized mixed oxide fuel aerosols postulated to result from fast reactor core disruptive accidents is a subject which is intensely evaluated in fast reactor safety analysis, containment design, and site selection licensing procedure. In this program,

surrogate uranium oxide aerosols produced by vapor condensation of super-heated liquid UO_2 have been produced in a variety of ways and have been intercompared with respect to particle morphology, number concentration, deposition behavior, surface area, oxygen content, and diffusion, sedimentation, and agglomeration rates. It has been established that, within a relatively narrow range, the primary particles are nearly identical when examined for initial shape, and size distribution, and effective density. However, primary particles in those aerosols produced by the most rapid heating methods followed by nearly instantaneous cooling are smaller in size and generally spherical, while those produced by slower processes in combination with delayed cooling give rise to a large proportion of crystalline particles which result in more tightly bound agglomerates. Deposition behavior is not significantly affected by this difference. Stokes diameters, which can be rather accurately calculated from the rate of settling, compare favorably with aerodynamic mean diameters measured with inertial devices. Agglomerate sizes appear to follow the cube root of the maximum initial concentration. The HAARM-2 version of the HAA-3 aerosol code has been used to obtain detailed time-dependent predicted behavior on a reference closed volume. The interrelations observed suggest that, in a given system, many of the characteristics can be calculated after only a few cases have been experimentally measured.

757 (EPRI-NP—786) **Air—water countercurrent annular flow in vertical tubes. Interim report.** Bharathan, D. (Dartmouth Coll., Hanover, NH (USA). Thayer School of Engineering). May 1978. 61p. Dep. NTIS, PC A04/MF A01.

Air—water countercurrent flow characteristics in 2.5 and 5.1 cm vertical tubes are investigated. Experimental measurements include air and water flow rates, pressure losses, pressure gradients, and liquid fractions. Tube-end geometries are altered to study their influence on the flow characteristics. Liquid-fraction measurements indicate that the countercurrent flow may be divided into three regions based upon the relative magnitudes of interfacial and wall shear stresses. The dependence of interfacial friction factor on the liquid fraction is isolated. The mechanism limiting countercurrent flows within a tube is modelled by a simple theory. Salient features of the theory are demonstrated. Comparisons between the theory and some experimental data are presented.

758 (EPRI-NP—835) **SWELL3/SURGE: computer models for hydrodynamic response of Mark I suppression pools. Final report.** Chan, R.K.C.; Vander Vorst, M.J. (JAYCOR, Del Mar, CA (USA)). Jun 1978. 79p. Dep. NTIS, PC A05/MF A01.

The report describes in detail the analytical models, together with the computational techniques for their solution, that are used in a continuing effort to study the pool swell phenomenon in MARK I pressure suppression systems during a postulated LOCA. A calculation using $^1/_4$-scale test conditions as input is given as an example.

759 (HEDL-SA—1407) **Out-of-reactor transient fission gas release studies.** Hinman, C.A.; Slagle, O.D. (Hanford Engineering Development Lab., Richland, WA (USA)). 1978. Contract EY-76-C-14-2170. 19p. (CONF-780545—7). Dep. NTIS, PC A02/MF A01.

From Meeting of the American Ceramic Society; Detroit, MI, USA (6 May 1978).

The work described is a series of six laboratory thermal transient tests using fast neutron irradiated mixed oxide fuel material. These tests, called FGR tests for Fission Gas Release, were all performed on fuel sections cut from the fuel pin PNL-2-4, which had been irradiated in EBR-II. This pin was irradiated to an average burnup of 3.6 atom percent at 250 watts/cm. The objective of the tests was to determine the transient interactions of the fuel and retained fission gas under thermal conditions resembling a loss of sodium coolant flow type of hypothetical accident in a fast reactor. These data help provide the experimental base for the development of computer codes for modeling hypothetical reactor accidents.

760 (HEDL-SA—1525-FP) **Display of the predictions of large fast reactor safety analysis codes via computer-generated movies.** Lewis, C.H. (Hanford Engineering Development Lab., Richland, WA (USA)). May 1978. Contract EY-76-C-14-2170. 9p. (CONF-780698—1). Dep. NTIS, PC A02/MF A01.

From Northwest computer conference; Victoria, Canada (15 Jun 1978).

A number of computer codes have been written to attempt to predict the consequences of hypothetical accidents. These codes all have one thing in common: they produce reams of paper containing vast quantities of numbers. In an effort to make these numbers more comprehensible, certain graphical techniques have been employed; one of the most successful is the computer-generated movie. The elements necessary for the creation of a plot are presented.

761 (IKE—2-39) **Estimate to describe the transient phase of a vapor explosion.** Schwalbe, W.; BENZ, R. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Apr 1977. 95p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Using engineering methods an estimation is made to describe the pressure transient during a vapour explosion. Reactor conditions are considered. Therefore the fundamental equations are solved using the Rankine Hugoniot relations for simple geometrical conditions. The mechanical energy capacity of the compressed media is supposed to be known. Parameters of the model are the quantity of melt (or the mechanical energy capacity) and the distance between shock front and the centre of the explosion. In the considered cases the solutions demonstrate that some hundred kilogramms of corium melt are needed to endanger the reactor.

762 (INIS-mf—4198, pp v) **Working group 5: Safety.** Vinck, W. (COMMISSION OF THE EUROPEAN COMMUNITIES, BRUSSELS (BELGIUM). INDUSTRIAL, TECHNOLOGICAL AND SCIENTIFIC AFFAIRS). Mar 1976. (In French).

In Compilation of reports [prepared by various working groups on the evaluation of problems of utilizing nuclear energy in Belgium].

The technical aspects of safety for the LWR nuclear power plants, and a reprocessing plant are considered. The origin, the type and the extent of the risks for the civil populations are presented for normal working as well as accidental conditions. A general estimate of comparative risks is given for the nuclear industry with respect to other activities. The legal Belgian aspects and their applications, the kind and the quality of the technical testings, the back-fitting of plants are analysed. Considerations are given on the probabilistic analysis, the safety, and the off-shore power plants.

763 (KFK—2395) **Model describing the interaction of a core melt with concrete.** Alsmeyer, H.; BARLEON, L.; KOSTER, J.; MICHAEL, I.; MUELLER, U.; REIMANN, M. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit). Oct 1977. 49p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

During a hypothetical core meltdown accident, the core melt will interact with the concrete basement of the containment. For this process a theoretical model is derived describing the decomposition rate, which depends on the temperature of the core melt. The basic physical ideas have been confirmed by model experiments. The model is valid under the assumptions that the volume flux of the gaseous decomposition products is sufficient to maintain a continuous gas layer between melt and concrete and that no crusts are formed between melt and concrete. From the gas film, bubbles are detached and flow through the core melt. For the case of a homogeneous metallic phase a diffusion model is formulated for the oxidation of steel and for the reduction of steam to hydrogen.

764 **Organization of action to be taken in the event of a nuclear accident in the nuclear power stations of Electricite de France.** Martin, J.J. (ELECTRICITE DE FRANCE, 93 - SAINT-DENIS. SERVICE DE LA PRODUCTION THERMIQUE). pp 325-336 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977). (In French)

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

Depending on the magnitude of the accident in a nuclear power station, the organization of action provides for calling in only the members of the teams on emergency duty if the accident is localized or for putting into effect a structured emergency plan if the accident goes much beyond the confines of the monitored zone. The emergency plan calls for establishing four command posts, the functions of which are specified. Radiological data are centralized at a monitoring command post whose task is to analyse the situation for the management command post. The latter takes decisions which apply to the interior of the site and provides information to the civil defense services at the prefecture level. Any action to be taken outside the site lies within the competence of the prefecture services, which can draw on the resources of the Ministry of Health and the Commissariat a l'energie atomique. Analysis of some incidents in EDF power stations, which are described briefly, has shown the need to facilitate the work of the responsible officials by the preparation of simple charts or schemes which can be used for making an estimate quickly but on the higher side of the potential dose commitment for the public.

765 (NEDO—21297(Rev.1)) **Mark II Containment Supporting Program report.** (General Electric Co., San Jose, CA (USA). Nuclear Energy Projects Div.). Mar 1978. 115p. General Electric Co., San Jose, CA.

The Supporting Program Report (SPR) provides a detailed description of project management information in an integrated format for the Mark II Containment Supporting Program. The SPR defines the objectives of the Containment Supporting Program, gives task descriptions and displays the integration of the activities leading to comfirmation of loads used for the evaluation of the

containment by the individual licensees. Included for reference purposes is a brief summary of the historical background related to the Mark II Containment Program.

766 (NEDO—21606) **Mark III one-third area scale submerged structure tests.** Chuang, T.H. (General Electric Co., San Jose, CA (USA). Boiling Water Reactor Systems Dept.). Oct 1977. 38p. General Electric Co., San Jose, CA.

A series of tests on submerged structures was performed in the Mark III 1/3 area scale Pressure Suppression Test Facility (PSTF) under simulated loss-of-coolant accident conditions. The tests utilized five cantilevered pipes as test targets, and were run using liquid blowdowns with two break sizes (2 1/2" and 1" venturi). Bending moments on the targets were measured with strain gages during the entire blowdown transient. Although particular emphasis was placed on water jet and LOCA bubble loads, condensation and chugging loads were also examined.

767 (NEDO—21627) **Mark I Containment Program. 1/4 Scale Pressure Suppression Pool Swell Test Program: scaling evaluation. Task number 5.5.1.** Galyardt, D.L.; Hayes, C.G.; Kushman, S.L. (General Electric Co., San Jose, CA (USA). Nuclear Energy Engineering Div.). Jan 1978. 205p. General Electric Co., San Jose, CA.

Test results for Part I of the 1/4-Scale Pressure Suppression Pool Swell Test Program are presented together with an evaluation of the hydrodynamic scaling laws. The scaling laws provide for experimental modeling of the pool swell phenomenon that would result from a postulated Loss-of-Coolant Accident (LOCA). Twenty-four tests were performed in the 1/4-Scale Test Facility. Two conditions of both drywell pressurization rate and initial drywell/wetwell differential pressure (ΔP) were tested. Data from these tests were compared with data from earlier tests in the 1/12 Scale Test Facility, which is geometrically similar to the 1/4 Scale Test Facility. Comparisons of the 1/12 and 1/4 scale data, related on the basis of the hydrodynamic scaling laws, indicate a high degree of similitude and thus provide experimental verification of the scaling laws. The sole restriction in regard to the confirmation of the scaling laws is the downforce for which scaling has been confirmed only at the full ΔP test condition.

768 (NUREG—0090(Vol.1)(No.1)) **Report to Congress on abnormal occurrences, January—March 1978.** (Nuclear Regulatory Commission, Washington, DC (USA)). 14 Apr 1978. 27p. NTIS $4.50.

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence as an unscheduled incident or event which the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. The report, the twelfth in the series, covers the period from January 1 to March 31, 1978. The following incidents or events in that time period were determined by the Commission to be significant and reportable: (1) There was one abnormal occurrence at the 68 nuclear power plants licensed to operate. The event involved insulation failures in containment electrical penetrations. (2) There were no abnormal occurrences at fuel cycle facilities (other than nuclear power plants). (3) There were no abnormal occurrences at other license facilities. (4) There was one abnormal occurrence reported by an Agreement State Licensee. The event involved an overexposure of a radiographer. The report also contains information updating previously reported abnormal occurrences.

769 (NUREG—0219) **Nuclear security personnel for power plants. Content and review procedures for a security training and qualification program.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Jun 1978. 168p. NTIS $8.00.

The applicant and licensee training and qualification plans will outline the process by which guard, watchman, armed response persons and other members of the security organization will be selected, trained, equipped and qualified. This plan should contain: (1) job descriptions for all security positions; (2) duties defined for all positions; (3) critical tasks defined for all duties; (4) skills, knowledge and abilities defined for all critical tasks; (5) performance objectives stated for all critical tasks; and (6) training and qualification plans to train and test to appropriate performance objectives. The document gives guidance on the preparation of this training and qualification plan and contains three parts: (1) an introduction to and brief explanation of job analysis and performance objectives; (2) a statement of the information that should be submitted in response to the requirements and the NRR review procedures; and (3) a sample qualification submittal.

770 (NUREG—0323) **Occupational radiation exposure at light water cooled power reactors, 1976.** Johnson, L.A. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Management Information and Program Control). Feb 1978. 72p. NTIS $5.25.

This report presents an updated compilation of occupational radiation exposures at commercial light water cooled nuclear power reactors (LWRs) for the years 1969 through 1976. The information contained in this document was derived from reports submitted to the United States Nuclear Regulatory Commission in accordance with requirements of individual plant Technical Specifications, and in accordance with Part 20.407 of Title 10, Chapter 1, Code of Federal Regulations (10 CFR Part 20.407). An additional 9 LWRs completed a full calendar year of commercial operation for the first time in 1976, increasing the total to 53 operating nuclear power plants. The number of personnel monitored at LWRs increased approximately 34 percent in 1976, and the average collective dose to personnel (man-rems per reactor-year) increased 9 percent over the 1975 average. The average number of personnel receiving measurable exposure per reactor increased 7 percent, and the average exposure per individual in 1976 was 0.7 rem per person.

771 (NUREG/CR—0034) **Steam—water mixing and system hydrodynamics program. Task 4. Quarterly progress report, October 1, 1977—December 31, 1977.** Carbiener, W.A.; Cudnik, R.A.; Dykhuizen, R.C.; Flanigan, L.J.; Liu, J.S. (Battelle Columbus Labs., OH (USA)). 1978. 69p. (BMI—1993). NTIS $5.25.

Experimental studies were conducted in a 2/15-scale model of a four-loop pressurized water reactor at pressures to 75 psia to extend the understanding of steam-water interaction phenomena and processes associated with a loss-of-coolant accident. Plenum filling studies were conducted with hydraulic communication between the cold leg and core steam supplies and hot walls, with both fixed and ramped steam flows. Comparisons of correlational fits have been made for penetration data obtained with hydraulic communication, fixed cold leg steam, and no cold leg steam. Statistical tests applied to these correlational fits have indicated that the hydraulic communication and fixed cold leg steam data can be considered to be a common data set. Comparing either of these data sets to the no cold leg steam data using the statistical test indicated that it was unlikely that these sets could be considered to be a common data set. The introduction of cold leg steam results in a slight decrease in penetration relative to that obtained without cold leg steam at the same value of subcooling of water entering the downcomer. A dimensionless parameter which is a weighted mean of a modified Froude number and the Weber number has been proposed as a scaling parameter for penetration data. This parameter contains an additional degree of freedom which allows data from different scales to collapse more closely to a single curve than current scaling parameters permit.

772 (NUREG/CR—0069) **Baseline plenum filling behavior in a 2/15-scale model of a four loop pressurized water reactor.** Cudnik, R.A.; Flanigan, L.J.; Dykhuizen, R.C.; Carbiener, W.A.; Liu, J.S. (Battelle Columbus Labs., OH (USA)). Mar 1978. 256p. (BMI—1997). NTIS.

Baseline experimental studies of plenum filling behavior in a 2/15-scale model of a four loop pressurized water reactor are discussed and the experimental results are presented. The experimental studies have investigated ECC penetration behavior, hot wall effect on plenum filling, cold leg steam effects on penetration, and plenum filling during ramped steam flow transients. When compared in terms of J* parameters, the 2/15-scale data fell slightly below the 1/15-scale data, suggesting that J* does not completely account for size effects. Limited comparisons in terms of the K* parameters showed that the 2/15-scale data fell above the 1/15-scale data. The J* parameter appeared to provide a better representation of the 1/15- and 2/15-scale data than did the K* parameter. A form of the Wallis correlation modified to account for condensation has been used to correlate the 1/15- and 2/15-scale data. A similar form with an additional scale dependence was found to over-compensate for size effects. Limited hot wall tests showed that the water delivery delay time is decreased at 2/15-scale in comparison to that observed at 1/15-scale. Cold leg steam acts to reduce penetration beyond that anticipated due to the heating of the ECC water. Penetration is not affected by cold leg steam operating condition, that is, by whether the cold leg steam supply is fixed or can hydraulically communicate with the core steam supply. Initiation of plenum filling in ramped steam transients with equilibrium walls occurred at a value of the parameter J*/sub g/ at which 100 percent penetration was predicted to occur based on the steady-state penetration data correlation. In ramped steam transients with hot walls, the initiation of plenum filling was delayed on the order of 2 to 5 seconds beyond when it was predicted using the J*/sub g/ values for 100 percent penetration based on the steady-state data correlation.

773 (NUREG/CR—0098) **Development of criteria for seismic review of selected nuclear power plants.** Newmark, N.M.; Hall, W.J. (Newmark (Nathan M.) Consulting Engineering Services, Urbana, IL (USA)). May 1978. 53p. NTIS $5.25.

The purpose of this report is to set forth seismic criteria and design concepts applicable to review analyses and upgrading for selected nuclear power plants, although the principles are applicable

generally to older operating plants. At the outset, it is expected that the review process would consist of two general tasks, one pertaining to detailed review of the existing plant in the light of applicable review criteria and the second involving detailed design and analysis studies to develop the desired (and possible) upgrading of the seismic resistance. It is envisioned that the detailed review would encompass inspection of the plant, review of existing documentation (reports, plans, and calculations) as appropriate with identification of those systems which realistically and economically are amenable to upgrading. As a part of this review it may be desirable to carry out a risk analysis to help provide a basis for the decisions that must be made as to the desirability and advantages of carrying out the upgrading.

774 (NUREG/CR—0115) **Effects of energy losses of arbitrary magnitude on fuel quality, vapor density, and bubble diameter in an idealized expansion of mixtures of UO_2 and Na.** Bertini, H.W.; White, J.S. (Oak Ridge National Lab., TN (USA)). Jul 1978. Contract W-7405-ENG-26. 111p. (ORNL/NUREG/TM—185). Dep. NTIS, PC A06/MF A01.

A method is developed for calculating the characteristics of the expected bubble in capacitor-discharge UO_2 vaporization experiments in sodium. These characteristics are the quality of the vaporized UO_2 and its vapor density and the bubble diameter. Results are presented in tabular form for a parametric study covering the range of initial and final states to be expected in these experiments and for a variety of energy losses and mixtures of UO_2 and Na. These data can also be used for sensitivity studies of the fuel quality and vapor density in a bubble that might be formed from a hypothetical core-disruptive accident in a liquid-metal fast breeder reactor. In order to facilitate the calculations, idealized expansions are assumed, that is, expansions that are free of intervening structure and in which thermodynamic equilibrium exists at all times.

775 (NUREG/CR—0121) **Progress on lower plenum voiding. Quarterly progress report, January 1—March 31, 1978.** Crowley, C.J.; Rothe, P.H. (Creare, Inc., Hanover, NH (USA)). May 1978. 84p. NTIS $6.00.

Recent results of a continuing program to develop an analytical and empirical model of plenum filling in a $^1/_{15}$-scale model of a Pressurized Water Reactor (PWR) are described. The topical section of the report presents new lower plenum voiding (LPV) experimental data from three vessels ranging in size from approximately $^1/_{30}$ to $^1/_{10}$ PWR scale. As in previous investigations of lower plenum voiding, extensive parametric studies have been performed to determine the effects of steam and water flow rates and geometry, particularly on the equilibrium water level depression. The current work has focused on tests in a transparent vessel (1/30 scale) with an extended range of the flow parameters and various special studies all intended to directly examine the fluid dynamic behaviors. The major flow regimes in these tests have been identified and documented with photographs. In particular, an abrupt flow regime transition has been found which is a likely cause of apparent inconsistencies between previous experiments. The report also briefly describes the past quarter's efforts which included condensation-induced transient tests at a vessel pressure of 115 psia, and scoping tests of the effect of lower plenum flashing on plenum liquid inventory in the $^1/_{15}$-scale vessel model.

776 (NUREG/CR—0138) **Effect of containment venting on the risk from LWR meltdown accidents.** Cybulskis, P.; Wooton, R.O.; Denning, R.S. (Battelle Columbus Labs., OH (USA)). May 1978. 41p. (BMI—2002). NTIS $4.50.

Many of the high-consequence accident sequences in the Reactor Safety Study (WASH-1400) involved containment failure by overpressurization. One way to relieve pressure and avoid containment failure is by venting of the containment atmosphere. The study undertook to develop some quantitative insight into the potential effect on public risk of venting and filtering the containment atmosphere for this class of accidents. The results of the Reactor Safety Study were examined to identify the dominant accident sequences in which containment venting could be expected to have an impact. The effects on fission product release for these sequences due to various modes of venting and/or filtering were then evaluated. The results for these selected dominant sequences were then used as a guide to infer the overall effects of containment venting on reactor accident risks. The potential impact on both the Reactor Safety Study PWR and BWR designs were considered. The results indicate that for the PWR design considered venting alone will not lead to an appreciable reduction in overall risk of reactor meltdown accidents. Filtered venting could reduce the likelihood of the accidents with very high consequences that were found to dominate the risk in WASH-1400. IN PWR accidents involving loss of containment heat removal containment venting could significantly delay the start of core melting and thus offer the possibility to effect repairs and avoid core melting. For the BWR design considered, filtered venting will not lead to an appreciable reducton of overall risk due to the dominance of several transient accident sequences in which venting was found to have little beneficial effect. The maximum benefit that could be derived from filtered venting appears to be about an order of magnitude reduced in risk; beyond this containment modes not affected by venting appear to be controlling.

777 (NUREG/CR—0147) **Steam—water mixing and system hydrodynamics program. Task 4. Quarterly progress report, January 1—March 31, 1978.** Cudnik, R.A.; Dykhuizen, R.C.; Collier, R.P.; Flanigan, L.J.; Liu, J.S. (Battelle Columbus Labs., OH (USA)). May 1978. 146p. (BMI—2003). NTIS $7.25.

Experimental studies were conducted in both $^1/_{15}$- and $^2/_{15}$-scale models of a four-loop pressurized water reactor at pressures to 75 psia to extend the understanding of steam-water interaction phenomena and processes associated with a loss-of-coolant accident. Studies in the $^1/_{15}$-scale steel model included quasi-steady penetration tests with an oversize gap and plenum filling tests using both steam and air. The $^1/_{15}$-scale transparent model was used for plenum filling benchmark tests with augmented downcomer instrumentation. The transparent model was also used for quasi-steady penetration and sweepout tests with special hardware. Model development tests were initiated in the $^2/_{15}$-scale model to support ongoing analytical model development. These tests included quasi-steady penetration tests with high and low subcooling and plenum filling repeatability tests. Plenum filling at $^1/_{15}$-scale has been characterized. A general theoretically-developed scaling model, based on Helmholtz instability analysis is presented. A general technique for condensation scaling, which is applicable to the Helmholtz model, is discussed.

778 (NUREG/CR—0148) **Physics of reactor safety. Quarterly report, January—March 1978.** (Argonne National Lab., IL (USA)). Jun 1978. Contract W-31-109-ENG-38. 52p. (ANL—78-52). Dep. NTIS, PC A04/MF A01.

This report summarizes work done on reactor safety, Monte Carlo analysis of safety-related critical assembly experiments, and planning of Safety-Related (ZPR) experiments. Work on reactor core thermal-hydraulic code development is also included.

779 (NUREG/CR—0181) **Barrier penetration database.** Fainberg, A.; Bieber, A.M. Jr. (Brookhaven National Lab., Upton, NY (USA)). May 1978. 48p. NTIS $4.50.

The document is intended to supply the NRC and nuclear power plant licensees with basic data on the times required to penetrate forcibly the types of barriers commonly found in nuclear power plants. These times are necessary for design and evaluation of the physical protection system required under 10CFR73.55. Each barrier listed is described in detail. Where minor variations in the basic barrier construction result in essentially the same penetration time, the variations are described. Figures of barriers requiring further clarification are presented in sequential order. For each barrier, the penetration time listed is that for the hand-carried portable countermeasure which would allow fastest penetration. If two alternative countermeasures could penetrate a given barrier in about the same time, both are given. The approximate weights of countermeasures are given in order to allow estimation of the total weight of equipment which might be required to penetrate a given series of barriers. In some cases, different kinds of countermeasures are specified for very similar barriers. For example, in the discussion of walls, heavy hand tools are specified in some cases and explosives in others. This apparent lack of consistency is due to a lack of systematically collected data. In all cases, only penetration times are cited which can be substantiated by reference to the literature, and thus consistent data were not always available. The penetration times are listed with a standard deviation range. This range is intended to give some idea of the possible variations in penetration times which might be expected between several roughly equally experienced adversaries. The source of the time listed is given for each barrier, and a complete list of the references used appears at the end of the report.

780 (NUREG/CR—0219) **Numerical study of apparatus scaling in a pressurized water reactor. Status report, May 1978.** Daly, B.J. (Los Alamos Scientific Lab., NM (USA)). Jun 1978. Contract W-7405-ENG-36. 38p. (LA—7387-SR). Dep. NTIS, PC A03/MF A01.

The K-TIF numerical method for calculating the transient dynamics of two interpenetrating fluids has been extended and applied to the study of scaling of the downcomer and lower plenum regions of a pressurized water reactor during a hypothetical loss of coolant accident. Tentative criteria are established for judging the similarity of flows at different apparatus scales. These criteria are used to evaluate various procedures for specifying inflow velocities of the time varying steam flow from the reactor core and the emergency core coolant supply to determine the most appropriate procedure for modeling full scale phenomena with small scale experiments. The sensitivity of scaling relationships to lower plenum pressure levels is examined by comparing results obtained at pressures that are typical of small-scale experiments with those at higher pressures. Sensitivity studies are also performed to determine the

importance of various properties of the theoretical model and the numerical calculation procedure.

781 (NUREG/CR—0221) **Model for condensation oscillations in a vertical pipe discharging steam into a subcooled water pool.** Kowalchuk, W.; Sonin, A.A. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Mechanical Engineering). Jun 1978. 67p. NTIS $5.25.

A relatively simple model is presented for the hydrodynamic oscillations which occur when steam is discharged from a vertical pipe into a subcooled water pool. Condensation is assumed to occur at the steamwater interface only, and the rate is assumed to be limited either by the turbulent convection of the latent heat into the water or by the kinetic transport of steam to the interface, whichever is the slower. Rate equations are postulated for both limits. The model neglects acoustic effects in the steam inside the downcomer, and deals with the hydrodynamics of the water pool in a simplified fashion. Sample calculations are presented for various assumed values of the empirical coefficients which appear in the condensation rate equations, and for various pipe lengths, submergences, loss coefficients, etc. Scaling laws are derived, and the prospects of small-scale modeling are discussed.

782 (NUREG/CR—0224) **Multiphase transients with coolant and core materials in LMFBR core disruptive accident energetics evaluations.** Theofanous, T.G. (Purdue Univ., Lafayette, IN (USA). School of Nuclear Engineering). Jun 1978. 298p. NTIS $11.75.

An overview of core disruptive accidents in LMFBRs and an assessment of their potential for energetic consequences are presented. Areas in which current state-of-the-art is found inadequate are identified. In particular the early post disruptive period (called herein Transition to the Transition Phase) is identified as a key area having received inadequate attention to date. Further the idea of mild dispersal from a fully developed Transition Phase at decay heat power levels does not appear justified. However considerable question exists as to the attainability of such full core pool under accident conditions. Specific recommendations for research work in relation to licensing needs are presented.

783 (NUREG/CR—0238) **Power-cooling-mismatch test series. Test PCM-4. Postirradiation examination.** Seiffert, S.L.; Cook, T.F. (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1978. Contract EY-76-C-07-1570. 325p. (TREE—1230). Dep. NTIS, PC A14/MF A01.

Test PCM-4, conducted in a pressurized water reactor (PWR) test loop in the Power Burst Facility at the Idaho National Engineering Laboratory, used four 1.01-m-long, unirradiated PWR-type zircaloy-clad fuel rods. The four rods were subjected to a preconditioning period, followed by four separate flow-reduction, departure from nucleate boiling test cycles performed at linear rod peak powers up to an average of 69 kW/m and at minimum coolant mass fluxes of 600 kg/(s . m^2). All four rods were operated in film boiling conditions during the fourth (final) test cycle for times varying up to 140 s prior to manual reactor shutdown. The overall conditions and changes in the fuel and cladding that occurred as a consequence of film boiling operation are discussed. Cladding temperatures estimated for various circumferential and axial positions along the film boiling region of each test rod are presented. Cladding deformation from collapse and bowing are reported. Cladding embrittlement associated with high temperature cladding oxidation reaction with the coolant and the fuel is evaluated and comparisons with fuel failure criteria are presented. Effects of film boiling on fuel restructuring are also presented.

784 (NUREG/CR—0252) **Quarterly technical progress report on water reactor safety programs sponsored by the Nuclear Regulatory Commission's Division of Reactor Safety Research, April—June 1978.** (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1978. Contract EY-76-C-07-1570. 104p. (TREE—1219). Dep. NTIS, PC A06/MF A01.

Water reactor safety research is summarized for the following programs: Semiscale, LOFT, thermal fuels behavior, code development and analysis, code verification and applications, and the 3-D protect. The Semiscale Program reports the performance of the first two tests in the new Mod-3 system and an evaluation of two LOFT counterpart tests, one (Test S-06-3) an NRC standard problem. The LOFT Experimental Program reports significant results from the final test in the nonnuclear test series and summarizes the objectives of the first LOFT nuclear test series. The Thermal Fuels Behavior Program reports on the various test series in the PBF reactor (including results of a power-cooling-mismatch test), and presents discussions of failed fuel rod behavior and vapor explosion criteria. The Code Development and Analysis Program reports progress in developing an improved version of the RELAP4 code and a successful linking of two codes, RELAP4 (a blowdown reflood code) and FRAP-T (a fuel analysis code). The Code Verification and Applications Program reports progress in verifying the RELAP4/MOD6 and FRAP-T4 codes and describes the NRC/FSR Data Bank Program, which is intended to collect, store, and provide access to experiment data on reactor safety. The multinational 3-D Experiment Project reports design, analysis, and instrumentation development in support of German and Japanese reflood experiments.

785 (NUREG/CR—0268) **Downcomer fluid phenomena in LOFT nonnuclear LOCEs.** Batt, D.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Aug 1978. Contract EY-76-C-07-1570. 63p. (TREE—1139). Dep. NTIS, PC A04/MF A01.

Downcomer fluid phenomena which affect the delivery of emergency core coolant (ECC) to the core area and influence the thermal-hydraulic behavior of a nuclear reactor during a loss-of-coolant accident (LOCA) are identified and discussed. The experimental results from the Loss-of-Fluid Test (LOFT) facility are compared with results from the Semiscale system and with analytical model results from the RELAP4 computer code. Suggestions are made for best estimate code improvements or modifications, and the analysis of fluid phenomena is extended to large pressurized water reactor response during a LOCA. Phenomena examined include asymmetric flow in the downcomer, lower plenum voiding, ECC bypass, condensation, accumulator nitrogen injection, and fluid oscillations during refill.

786 (NUREG/CR—0269) **Light water reactor fuel response during reactivity initiated accident experiments.** Fujishiro, T.; Johnson, R.L.; MacDonald, P.E.; McCardell, R.K. (Idaho National Engineering Lab., Idaho Falls (USA)). Aug 1978. Contract EY-76-C-07-1570. 187p. (TREE—1237). Dep. NTIS, PC A09/MF A01.

The report presents a summary of existing test results, data correlations, and interpretations relevant to the current understanding of light water reactor fuel behavior under conditions of a reactivity initiated accident. Experimental data are included from test programs previously carried out in the Capsule Driver Core (SPERT Project) and TREAT facilities at the Idaho National Engineering Laboratory and currently ongoing in the Japanese Nuclear Safety Research Reactor. Test results are summarized and presented, primarily as derived from the literature, in terms of the thresholds, modes, and consequences of fuel rod failure. The effects of fuel rod design variations, environmental variations, elevated burnup, and fuel waterlogging are described. The data are correlated and analyzed to illustrate trends and salient features. Where possible, interpretations are made in terms of basic fuel properties and capsule environment.

787 (ORNL/NUREG/TM—210) **PWR Blowdown Heat Transfer Separate-Effects Program. Thermal-Hydraulic Test Facility experimental data report for test 167R.** Clemons, V.D.; Hedrick, R.A.; White, M.D. (Oak Ridge National Lab., TN (USA)). 26 May 1978. Contract W-7405-ENG-26. 52p. (NUREG/CR—0108). Dep. NTIS, PC E03/MF A01.

Reduced instrument responses are presented for Thermal-Hydraulic Test Facility (THTF) test 167R, which is part of the ORNL Pressurized-Water Reactor (PWR) Blowdown Heat Transfer Separate-Effects Program. The objective of the program is to investigate the thermal-hydraulic phenomenon governing the energy transfer and transport processes that occur during a loss-of-coolant accident in a PWR system. Test 167R was conducted to obtain thermal-hydraulic and CHF information in THTF bundle 1 with an intact cold leg. The primary purpose of this report is to make the reduced instrument responses during test 167R available. These are presented in graphical form in engineering units and have been analyzed only to the extent necessary to ensure reasonableness and consistency.

788 (SAND—77-1975) **Advanced Reactor Safety Research Program. Quarterly report, July—September 1977.** (Sandia Labs., Albuquerque, NM (USA)). May 1978. Contract EY-76-C-04-0789. 148p. Dep. NTIS, PC A07/MF A01.

Progress is summarized in the following LMFBR-related safety studies: (1) accident energetics, (2) core debris behavior, (3) sodium containment and structural integrity, (4) research of elevated temperature design criteria, (5) fuel motion detection, (6) ACPR fuel motion system, and (7) advanced reactor safety research assessment. (DG)

789 (SAND—78-0184C) **Spent fuel heatup following loss of water during storage.** Benjamin, A.S.; McCloskey, D.J. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 7p. (CONF-780622—18). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; San Diego, CA, USA (18 Jun 1978).

Spent fuel assemblies from light water reactors are typically stored for one year or more in the reactor spent fuel pool and then transported for long-term storage at an off-site location. Because of the design, construction, and operation features of spent fuel storage pools, an accident that might drain most of the water from a pool is assessed as being extremely improbable. As a limiting case, however, a hypothetical incident involving instantaneous draining of all the

water from a storage pool has been postulated, and the subsequent heatup of the spent fuel elements has been evaluated. The model is analyzed, and results are summarized.

790 (UNI—664) **Application of RELAP4 to NUSAR accident analysis model development, description, and analysis, 1976—1977.** Madsen, D.R. (United Nuclear Industries, Inc., Richland, WA (USA)). 16 Jun 1978. Contract EY-76-C-06-1857. 332p. Dep. NTIS, MF A01.

Portions of document are illegible.

This document describes the procedure used by UNI to develop and use the RELAP4 code for analysis of the N-Reactor system during a LOCA. The code modifications required are described as are the responses to the 10CFR50 App. K requirements. Each of the models used in the analysis is described and discussed. This document is the primary reference for the LOCA analysis presented in the N-Reactor Updated Safety Analysis Report (NUSAR).

791 (UNI—664(Add.1)) **Application of RELAP4 to NUSAR accident analysis revised manifold and pressure tube break analysis.** Madsen, D.R. (United Nuclear Industries, Inc., Richland, WA (USA)). 26 Jun 1978. Contract EY-76-C-06-1857. 162p. Dep. NTIS, PC A08/MF A01.

This document describes the RELAP4 reanalysis of the hot and cold-leg manifold break and pressure tube break cases. The models used are described as well as the results. A justification for use of a correction factor for the Moody critical flow model is presented. A discharge coefficient sensitivity study and a CV-5 valve response study are also presented for the cold-leg manifold analysis.

792 (UNI—1094) **Inavertent addition of cold water from an isolated steam generator cell.** Buchanan, D.T. (United Nuclear Industries, Inc., Richland, WA (USA)). 31 May 1978. Contract EY-76-C-06-1857. 10p. Dep. NTIS, PC A02/MF A01.

During the NUSAR review, a loss of isolation of steam generator Cell 6 by the inadvertent opening of the supply valve PCSV-6203 and the return valve PCRV-6203 was postulated. It was requested that this accident be analyzed to determine the effect on core reactivity if the 38°C (100°F) water in the cell was pumped to the core with a resultant rapid thermal transient. The purpose of this analysis is to supply the thermal transient for input to further reactivity analyses. A thermal analysis of the water and pipe between the PCSV-6203 valve and the core inlet was conducted using the TUBE Code. The results are presented.

793 (UNI-NUSAR—335-1) **Production test No. 379: test of HPI system response for single bus scram. Final report.** Flickinger, J.K. (United Nuclear Industries, Inc., Richland, WA (USA)). 1975. Contract EY-76-C-06-1857. 9p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

The test was performed 5-9-75 at the time of reactor shutdown for the summer outage. The purpose of the test was to verify that the response of the primary coolant inventory control system is adequate to prevent draining the pressurizer and to avoid actuation of the primary loop pressure relief valves during a full power scram shrinkage transient, assuming a simultaneous loss of A bus electrical power to the high pressure injection pumps. A second purpose of the test was to dynamically test a series of modifications made to improve the reliability and performance of the High Pressure Injection (HPI) and Pressurizer Level and Pressure Control Systems. Satisfactory control of the shrinkage transient had been demonstrated by reactor scrams from full power when both A and B buses were in service; however, the adequacy of inventory control had never been tested for the case of a full power scram and a simultaneous loss of the two A or the two B bus, HPI pumps.

794 (WARD-OX—3045-35) **Application of LIFE transient codes to experiment and core design.** Roth, T.S.; Sundquist, B.E.; Biancheria, A. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Feb 1978. Contract EY-76-C-02-3045-009. 26p. AT.

The LIFE series of codes model cylindrical fuel pin behavior for various types of fast breeder reactor fuels. Results from the transient codes which analyze off-normal, non-core disruptive events up to cladding breach are discussed. The results reported are from initial applications of the code to experiment and core design. The core design application involved analysis of mixed oxide fuel pin performance during design basis upset and emergency transients. The upset events considered produce moderate cladding damage. The emergency event is more severe, consuming about 60 percent of the cladding lifetime. Sensitivities of damage to variations in fabricated gap size, cladding swelling, and thermal hydraulic environment were examined. A mixed carbide 50 cents/sec transient experiment to be performed in TREAT was studied focusing on the peak power necessary to produce incipient failure. Sensitivities of cladding damage and strain to variations in initial fuel cladding mechanical interaction, thermal hydraulic environment, and fuel hot pressing were examined.

795 (WCAP—8587(Rev.1)(Suppl.1)) **Equipment qualification data packages: PWR-SD.** (Westinghouse Electric Corp., Pittsburgh, PA (USA). Water Reactor Divisions). 1978. 336p. Westinghouse Electric Corp., Pittsburgh, PA.

The purpose of the document is to provide additional details relative to both the performance requirements and test (or analysis) plans for Westinghouse PWR-SD supplied safety related electrical equipment. These details reflect the Westinghouse interpretation of IEEE-323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations" as described by WCAP-8587, Revision 1. Described are performance requirements and test (or analysis) plans for Westinghouse NSSS scope safety related electrical equipment which provide additional supplementary details beyond those given in WCAP-8587, Revision 1.

796 **Nuclear power stations as a safety problem.** Baumgartner, G.; Glauser, E.; Heimgartner, E.; Schneider, T. (Basler and Hofman, Ingenieare und Planer AG., Zuerich, Switzerland). *Schweiz. Bauztg.;* **95**: No. 44, 784-794(3 Nov 1977). (In German).

The problem of the safety of nuclear power stations is reviewed. The risk of a failure is analysed statistically. Comparison is made between the risk of a failure in a nuclear power station and the failure of other structures, e.g. high buildings, bridges and retaining dams. The probability of personal contamination by radiation is extremely low. The results of catastrophic failures of a nuclear power station are compared statistically with natural disasters, e.g. hurricanes, earthquakes, etc.

797 **Safety concepts and safety precautions.** Wenger, H. (Kernkraftwerk. (KKW), Beznau, Doettinger, Switzerland). *Schweiz. Bauztg.;* **95**: No. 44, 794-800(3 Nov 1977). (In German).

Safety of the various types of nuclear reactor (light water, heavy water, gas-cooled) is compared. Failures of various systems and components (e.g. cooling-medium failure) are analysed.

798 **Comparative study on various attenuation theories usually used for aseismatic design of reactor facilities.** Muto, K. (Tokyo Univ. (Japan)); Kobayashi, T. *Nippon Kenchiku Gakkai Ronbun Hokoku-shu;* No. 255, 35-48(May 1977). (In Japanese).

In the vibration analysis for the aseismatic design of reactor facilities, various attenuation theories have been used case by case. In this study, three attenuation theories of internal viscosity type, strain energy type and kinetic energy type were applied to the vibration analysis for a BWR type reactor building, and the respective results were compared. The three theories are explained briefly. Different damping factors were taken for the RC building, steel internal equipments and ground. The reactor building for a BWR of Mark 1 type was studied, and the mathematic vibration model involving those for the building, shield wall, primary containment vessel, gamma shield wall, reactor pressure vessel and foundation is shown. Natural frequency analysis, frequency response analysis and earthquake response analysis were carried out. Regarding the response of the building, the internal viscosity type and the strain energy type gave almost same values, but the kinetic energy type gave the value 1.2 times as large as the former values. In the response of the building, the first mode element is predominant, and the damping factors to the first mode caused these results. Regarding the maximum response acceleration and floor response spectra of internal equipments, the strain energy type and the kinetic energy type gave similar results, and the internal viscosity type gave smaller values.

799 **One-dimensional analyses on generation and propagation of pressure waves in compressible liquid resulting from fuel coolant interaction.** Miyazaki, K.; Fujii-e, Y. (Osaka Univ., Suita (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 5, 327-342(May 1977).

The pressure response obtained for a vertical column is identical to that resulting from the acoustic constraint model (which is adopted by Cho et al.) within the range of time required for the waves to traverse and retraverse the column at $t < l/c$ (t is time, l is length of liquid column, c is propagation velocity of pressure wave), but beyond this time point, the present analysis yields the response that differs according to the history of the waves. On the other hand, for the spherical compression waves propagating symmetrically outwards in coolant, the solution of this pressure is obtained using the step function and exp(-ct/R) (R is radius of fuel coolant interaction boundary). It is suggested that the predicted pressure should be reduced appreciably by adopting the rigorous solution of the spherical acoustic constraint model, combined with realistic values chosen for the interaction time.

800 **Development of nuclear power plants and safeguarding safe operation thereof.** Metke, E.; Novak, S. (Vyskumny Ustav Energeticky, Bratislava (Czechoslovakia)). *Energetika;* **27**: No. 2, 58-61(Feb 1977). (In Slovak).

The basic approaches are described for ensuring nuclear safety at different stages of the development of the nuclear power plant: the stages of the project design, production, construction and operation. Special attention is devoted to quality control, ranging from material for steel production up to the final product. Careful visual inspection is carried out, nondestructive testing and testing of the mechanical properties of the basic metal, the welds, the dimensions of the products, repeated nondestructive testing of the welds of the reactor pressure vessel following hydraulic tests. The main requirement for securing nuclear safety is the prevention of the melting of the core in case of maximum possible accident. The gravest is the LOCA accident. In order to check such accidents the primary coolant circuits of the nuclear power plants with 670-1200 MWsub(e) PWR reactors, currently in operation or under construction, are placed in containments which protect the environment from direct irradiation from uncontrolled leakage of fission products and from subsequent accidents. The full-pressure containment contains all released energy in case of accident. A constant underpressure is maintained in the containment of approximately 10-20 mm H_2O. The underpressure containment differs from the full-pressure containment by the considerably higher value of underpressure. The suppressed-pressure containments are equipped with systems having ice or water condensate. The double containment with suction of the intermediate space is a primary containment (e.g., full-pressure or suppressed-pressure) enveloped with a secondary containment. The assessment of the hazards to the population arising from the operation of a nuclear reactor shows that adopted safety measures (which may also be applied in Czechoslovakia) make them safer than other human activities by 2 or 3 orders and the risks are almost negligible.

801 Overview of the activated corrosion product reduction program for US power reactors. Murphy, T.D. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Reactor Regulation). *Atomkernenergie;* **30**: No. 4, 293-296(1977).

From 5. international reactor shielding conference; Knoxville, TN, USA (18 - 22 Apr 1977).

Recent studies have shown that radiation levels associated with reactor coolant components are increasing at US nuclear power plants. Recent experience also shows that occupational radiation exposure to personnel is also increasing. This paper discusses one aspect of reducing exposure to personnel, that is, recent developments in the reduction of existing corrosion product radioactivity in reactor coolant systems and the minimization of the formation and buildup of such activity.

802 Recent developments in training of the emergency organization at SSPB's nuclear power stations in Sweden. Ekholm, S. (NUCLEAR SAFETY DIV., SWEDISH STATE POWER BOARD, VAELLINGBY, SWEDEN). pp 281-290 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977).

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

In order not to exceed the risk figures given by Rasmussen we need a well-trained organization and a well-informed general public. The emergency organization is concerned with plant safety, personnel safety and district safety, and its management is entrusted to two sections, one at the nuclear power station and one organized by the County Administration. The training programme includes two films about nuclear risks during normal operation and emergency conditions including evacuation, which are shown at our nuclear sites to all workers and to the general public. There is also a special instruction film for the emergency organization, a 150-page lecture book used in conjunction with a 1-3 day basic course, and two check-list manuals, one for station personnel, and one for County Administration bodies. Before stations are permitted to produce power a full-scale emergency exercise must be carried out with press and TV coverage. Within two years a cheap iodine monitor and a computer producing a printout with isodose curves will be added to our emergency research programme. The programme satisfies Swedish regulations and current American requirements, and an English translation of the training package is available.

803 Basic principles for the prevention of excessive irradiation of staff and population in nuclear power plant emergencies. Turkin, A.D.; SAYAPIN, N.P. (INSTITUT BIOFIZIKI, MOSCOW (USSR)); TUROVSKII, V.D. (MINISTERSTVO ZDRAVOOKHRANENIYA SSSR, MOSCOW); LUZANOVA, L.M. (GOSUDARSTVENNYJ KOMITET PO ISPOL'ZOVANIYU ATOMNOJ EHNERGII SSSR, MOSCOW. INST. ATOMNOJ EHNERGII). pp 207-217 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977). (In Russian)

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

The continuing development of nuclear power and the siting of nuclear power stations in densely populated areas makes it necessary to work out and apply special measures to protect station staff, the general population and the environment from the effects of radiation in various operating regimes. There is at present no single, comprehensive solution to the problem of ensuring radiation safety at nuclear power plants; the goal can be attained only by applying a complex set of technological, engineering, medical and administrative measures. This paper examines the main design and operational approaches to preventing excessive irradiation of staff and population in nuclear power plant emergencies, a number of different classes of emergency being considered. Questions of the tactics to be followed when specific anti-emergency measures are called for are also discussed. Stress is laid on the reliability and radiation safety of nuclear power stations currently in operation.

804 Safety of high-parameter sodium loop. Paryzek, R. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). *Jad. Energ.;* **22**: No. 12, 443-447(Dec 1976). (In Czech).

The solution of problems of technical and fire safety is shown on the concrete example of the SMT-1 experimental sodium loop installed at the Institute of Nuclear Research at Rez. The general principles and measures adopted for the loop are described which were derived from a detailed analysis of the possible causes of failures or accidents. These causes include: leakage and cracks arising during production, leakage and cracks caused by the quick temperature changes in operation and by the incorrect heating up of circuits with solidified sodium, equipment failure caused by dilatation forces, by pressure increase above the permissible level and by the corrosive effects of sodium, accidents caused by failures in the measurement and loop control system, and leakage on the main container. The loop is equipped with an alarm system and closed-circuit television.

ENERGY STORAGE

805 (CONF-770955—, pp 376-384) **Research leading to the production and early use of numeric data banks of material properties and system analyses.** Hampel, V.E.; Quick, T.M. (Univ. of California, Livermore). 1977.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

In Proceedings of the second annual thermal energy storage contractors' information exchange meeting.

The project goals include: (1) creation of bibliographic and evaluated materials properties data bases for energy storage systems; (2) creation of storage technology characterization data bases; and (3) remote access to energy storage data bases for comparative analysis and decision making; flywheel and molten salts/TES bibliographic data bases are being completed. A molten salts/TES material properties data base is under development and A PDP-11/70 computer system is being set up to allow remote access to data bases.

MAGNETIC

REFER ALSO TO CITATION(S) 836

COMPRESSED GAS

806 (CONF-780599—1) **Application of air ejectors to the performance improvement and cost reduction of compressed air storage power plants.** Ahrens, F.W.; Ng, T.T.; Otis, D.R. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 27p. Dep. NTIS, PC A03/MF A01.

From CAES technology symposium; Pacific Grove, CA, USA (15 May 1978).

Ways in which air ejectors could be integrated into compressed air energy storage (CAES) power systems in order to achieve a reduction in costly air storage volume and a possible savings in air compression work are explored. Primary emphasis is given to a scheme involving multiple constant-volume caverns, with the pumping effect of the air ejector replacing the wasteful throttling process. The results presented cover a range of ejector efficiency and CAES system design conditions. It appears that volume reductions of 20 to 30% or more and compression work savings of 2 to 4% can be achieved.

807 (PNL-SA—6587) **Analysis of advanced compressed air energy storage concepts.** Kreid, D. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1977. Contract EY-76-C-06-1830. 54p. (CONF-780520—5). Dep. NTIS, PC A04/MF A01.

From 2. thermophysics and heat transfer conference; Palo Alto, CA, USA (24 May 1978).

An analysis is presented of a class of Advanced Compressed Air Energy Storage (CAES) concepts, which are designed to mini-

mize or eliminate the dependence on oil for firing the turbines. The analysis is based on a "Hybrid" CAES system that incorporates thermal storage and varying turbine inlet conditions. The extreme case of the hybrid is the adiabatic CAES concept where the sole source of energy to the cycle is the electrical power input to the compressors. The thermodynamic characteristics of these cycles are studied parametrically. In addition, the economics of the hybrid cycle, including the adiabatic cycle, are studied parametrically for the case where thermal storage in an aquifer is used. The results of the analysis conclude that the adiabatic CAES concept is technically feasible and that the storage efficiency would be comparable to or better than pumped hydro. However, the economic analysis concludes that heat storage in an aquifer is of questionable economic value since a recuperator can accomplish much the same effects at lower cost. The adiabatic concept using heat storage in an aquifer does not appear economic for foreseeable conditions.

THERMAL

REFER ALSO TO CITATION(S) 440, 447, 481, 482, 483, 484, 485

808 (CONF-770955—, pp 373-375) **Thermal energy storage: space heating technical validation.** Wolosewicz, R.M. (Argonne National Lab., IL). 1977.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

In Proceedings of the second annual thermal energy storage contractors' information exchange meeting.

The European experience with electric storage heating and systems studies of storage heating and cooling for application in the United States indicate that these technologies offer substantial energy conservation potential. Currently there is a pressing need to acquire and evaluate thermal energy storage (TES) cost and performance data under actual U.S. operating conditions. The proposed program will: acquire and evaluate TES heating baseline operating data; develop recommendations for improved TES heating system design; specify R and D needs; establish a facility for testing and evaluating conventional and prototype systems; and work to establish TES system standards.

809 (ORNL/SUB—7398/4) **Form-stable crystalline polymer pellets for thermal energy storage: high density polyethylene intermediate products. Final report, October 1, 1977—January 31, 1978.** Botham, R.A.; Ball, G.L. III; Jenkins, G.H.; Salyer, I.O. (Monsanto Research Corp., Dayton, OH (USA). Dayton Lab.). 1978. Contract W-7405-ENG-26. 84p. (MRC-DA—760). Dep. NTIS, PC A05/MF A01.

The primary objectives of this program were to demonstrate: (1) that form-stable high density polyethylene (HDPE), which has been shown to have desirable properties as a phase-change type of thermal energy storage material, could be produced by processing in a polyethylene plant for a projected price near 26 cents/lb; and (2) that the raw material, ethylene, will be available in the very long-term from alternate sources (other than petroleum and natural gas). These objectives were accomplished. Production of useful, form-stable HDPE pellets by radiation cross-linking was demonstrated. Such pellets are estimated to be obtainable at 26 cents/lb, using large-volume (> or equal to 10,000,000 lb/yr) in-plant processing. Well-developed technologies exist for obtaining ethylene from coal and plant (or biomass) sources, thus assuring its long-term availability and therefore that of polyethylene. A cost-benefit analysis of the HDPE thermal energy storage system was conducted over its 120 to 140°C optimum operating range which is most suited for absorption air conditioning. The HDPE is more cost effective than either rocks, ethylene glycol, or pressurized water and is even competitive with a hypothetical 5 cents/lb salt-hydrate melting in this temperature range. These results applied, as appropriate, to both air and liquid transfer systems.

CHEMICAL

810 (CONF-770955—, pp 346-351) **Sulfuric acid/water integrated chemical energy storage system.** Clark, E.C. (Rocket Research Co., Redmond, WA). 1977.

From ERDA-information exchange meeting for thermal energy storage program; Gatlinburg, TN, USA (29 Sep 1977).

In Proceedings of the second annual thermal energy storage contractors' information exchange meeting.

This program is divided into three phases. The goals of the completed initial phase were to determine the feasibility of using sulfuric acid and water as a chemical energy storage media, generate basic design concepts, and estimate the respective system costs. The second phase objectives are to select a concept for detailed sizing and scaling analysis, design and construct a subscale (approximately 100,000 Btu) closed loop demonstration system, conduct operational tests to verify system performance and efficiency, and provide recommendations for the third phase full-scale pilot plant design. Additionally, as an intermediate follow-on to Phase II, component optimization testing will be conducted using the subscale system and the economics and environmental impact for commercialization of the sulfuric acid system will be assessed. All of the tasks in Phase I have been completed and were reported during the previous contractors meeting in September 1976. During the initial Phase II effort starting in October 1976, the sulfuric acid heat pump concept with storage densities in excess of 600 Btu/lbm of dilute acid was identified. Currently, the Phase II sizing and scaling analysis has been completed as well as the design and procurement of the subscale system components. Initial evaluation tests are scheduled to start in October 1977.

BATTERIES

PERFORMANCE AND TESTING

811 (ATR—78(8114)-1) **Impedance measurements on sealed lead—acid cells.** Martinelli, M.R.; Zimmerman, A.H. (Aerospace Corp., El Segundo, CA (USA)). 10 May 1978. 26p. The Aerospace Corp., El Segundo, CA.

The impedance of sealed 2.5-ampere-hour lead—acid cells was measured as a function of state of charge at frequencies of 10 Hz to 500 kHz. The impedance of a small lead—acid wet cell employing flat-plate electrodes was also measured over this frequency range. Comparisons between the results for these two cell types indicate that impedances are sensitive to chemical and physical changes which accompany cell discharge. A model is proposed which relates inductive behavior for porous electrodes to the electrode structure. Double-layer capacities are estimated for the two types of lead—acid cells. 8 figures, 1 table.

812 **Advanced batteries for vehicle propulsion.** Burris, L.; Nelson, P.A. (Argonne Natl Lab, Ill). *SAE Prepr.;* No. 780458, 1-12(1978).

The paper surveys the state of research and development in rechargeable electric batteries. It concludes that the present lead-acid battery does not have sufficiently high performance, in terms of vehicle range, to attract a large market. Near-term research is aimed at improving the lead-acid battery and developing iron-nickel oxide and zinc-nickel oxide batteries. Beyond these near-term batteries are advanced batteries, such as lithium-aluminum/iron sulfide, sodium/sulfur, and zinc/chlorine. These systems promise much higher performance than any of the near-term battery systems--vehicle ranges approaching 200 miles at speeds and with acceleration and hill-climbing capabilities of gasoline-powered vehicles.

APPLICATIONS

REFER ALSO TO CITATION(S) 440, 954, 960, 961, 962, 963, 964, 966, 967, 969, 970, 971

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 182

813 (CONF-780132—) **DOE role in support of a small-scale appropriately distributed technology. Official transcript of public briefing and addendum.** (Department of Energy, Washington, DC (USA). Office of Consumer Affairs). Aug 1978. 169p. Dep. NTIS, PC A08/MF A01.

From Conference on DOR role in support of small scale appropriate distribution technology; Washington, DC, USA (26 Jan 1978).

This report first lists 94 questions raised relative to the DOE public briefing on appropriate technology. The keynote speaker was John O'Leary who gave some perceptions of the future. The introductory speech was given by Phillip S. Hughes. Panel members from DOE who provided answers to the questions were: Maxine Savitz, John Deutch, Robert Thorne, and Donald Beattie. (MCW)

814 (DOE/PR—0005) **Compendium of publicly available reports on procurement and financial assistance awards.** (Department of Energy, Washington, DC (USA). Div. of Procurement Management Systems and Analysis). Jul 1978. 103p. Dep. NTIS, PC A06/MF A01.

The public has shown a particular interest in the Department of Energy's procurement, contracting, and financial assistance programs. Procurement systems reports involve extensive information

on over 6,000 active prime contracts, grants, loan guarantees and agreements of several types, plus over 30,000 small purchase transactions. This Compendium eliminates some confusion and will serve the needs of most of the people who wonder what kind of procurement systems reports are available from the Department of Energy. This Compendium has three major sections. The Published Reports section includes computer-generated reports, which will be published annually with a cumulative monthly update. The annual reports will be published as of September 30, the end of the Federal Fiscal Year. Alongside each report is a summary of the report showing the data elements included in the report. When available, these reports can be obtained from your nearest Energy Extension Service office. A list of the Department of Energy's ten Energy Extension Service offices is included in this publication. The Unpublished Reports section is comprised of available, computer-generated reports with a summary of each report and a listing of data elements included in the report. Unpublished reports are reformats or subsets of information available in the published reports and are generated on a limited basis for repetitive Departmental needs. The Special Reports section contains formats or subsets of information on energy or energy-related projects. (MCW)

815 (HCP/W5148—01) **Energy Advisory Service for Texas. Final report.** (Texas A and M Univ., College Station (USA). Center for Energy and Mineral Resources). Jun 1978. Contract EY-76-S-05-5148. 151p. Dep. NTIS, PC A08/MF A01.

In 1975, the Texas Legislature appropriated funds for the creation of an Energy Resources Public Service Program at Texas A and M. The program was to consist of research, public service, and teaching activities in areas of concern to energy consumers in Texas and the nation. Then The Texas A and M Center for Energy and Mineral Resources (CEMR) was established to provide a single institutional focus for the energy-related programs of the entire university and to administer the state-funded Energy Resources Public Service Program. The University then proposed to support the creation of the Energy Advisory Service for Texas (EAST). EAST was formally organized on June 1. To realize the objectives of the EAST program, CEMR established an EAST program management group, expanded its existing information services activity, and contracted with other units of The Texas A and M University System to conduct programs for manufacturers, operators of public buildings, and the residential construction industry. Each of these activities is described in detail in this publication. In addition, case studies of the information services, manufacturers, public buildings, and residential construction activities are included as appendexes. In April 1977, ERDA issued a Program Research and Development Announcement inviting each of the 50 states and territories to submit proposals for pilot state Energy Extension Services. In August 1977, Texas was one of ten states selected to implement a pilot EES. The Texas proposal included an expanded version of all EAST activities and proposed a mechanism for a smooth transition from EAST to the Texas Energy Extension Service. The organization, management, and technical activities of the Texas EES are discussed. (MCW)

816 (LA—7154-PR) **Energy systems and statistics, July—September 1977.** Snyder, E.A. (comp.). (Los Alamos Scientific Lab., NM (USA)). Feb 1978. Contract W-7405-ENG-36. 28p. Dep. NTIS, PC A03/MF A01.

This report summarizes the statistical analysis and energy systems assessment activities of Los Alamos Scientific Laboratory (LASL) Group Q-12, Energy Systems and Statistics, during the last quarter of FY 1977, July—September. In the statistical analysis realm, water samples from the Anchorage area of Alaska were analyzed to learn if there were a treatment effect on the uranium results as determined by the fluorometric method. A new data base, OIL3, was created and analyzed for data verification within the lease, production, and revenue program support for the US Geological Survey. Development of Module B10 continued in support of the Geophysical Interpretive Aid System. Q-12 staff initiated interactions with Oak Ridge National Laboratory to schedule and plan the presentation of a short course on Bayesian reliability estimation. In addition, data from 27 impact tests on multihundred-watt radioisotope thermoelectric generators were analyzed to determine relationships between the test design variables and the failure types. The major emphasis of the analysis in the autopsy tissue program was altered during this quarter when Q-12 staff discovered that the time factor was a more important issue than originally believed. Time trends are now being uncovered. Statistical analyses of data relating to waste disposal problems and cervical cancer were also carried out during the quarter, as well as a theoretical study of the secondary structure of single-stranded nucleic acids. On the energy systems side, work forged ahead on such subjects as solar incentives and the National Energy Plan, energy boom towns, and the legal and institutional constraints on energy development, water issues in the West, the visibility issue, energy boom town models, energy storage systems, geothermal energy, and the costs of electronuclear fuel production.

817 (PB—281815) **Federal Energy Data System (FEDS): technical documentation.** Fuller, R.F. (Department of Energy, Washington, DC (USA). Energy Information Administration). Jun 1978. 116p. (DOE/EIA—0031/1; CRN—780301-00087). Dep. NTIS, PC A06/MF A01.

This report is a detailed documentation of the Federal Energy Data System, FEDS. Some of the more noteworthy features included in this volume are: (1) an explicit definition of each data series including source, methodology, naming conventions, and idiosyncrasies which do not follow directly from the published source; (2) table of contents and description for the on-line FEDS; (3) an explicit detailed description of the FEDS computer tape; (4) completed summary of conversion factors and scalers; (5) glossary of energy terms.

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 828, 831, 843, 844, 845, 847, 1425

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 23, 124, 824, 825, 826, 831, 834, 849, 856, 857, 1575

818 (ANL/EIS—10) **Energy resources technical training and development programs for American Indians.** Cameron, R.E.; White, W.S. (Argonne National Lab., IL (USA)). Aug 1978. Contract W-31-109-ENG-38. 26p. Dep. NTIS, PC A03/MF A01.

Because of the energy resources located on Native American owned lands, it is pertinent that the tribes on these reservations receive information, training, and technical assistance concerning energy and the environment and the decisions that must be made about energy-resource development. In the past, attempts to enlist Indians in technical-assistance programs met with little success because teaching methods seldom incorporated program planning by both tribal leaders and the technical training staff. Several technical-assistance programs given on reservations in the central and western parts of the country were conducted by Argonne National Lab.—programs that stressed practical, on-the-job experience through lecture, laboratory, and field studies. Each program was designed by ANL and tribal leaders to fit the needs and concerns of a particular tribe for its environment. The individual programs met with an impressive degree of success; they also prompted several Indians to pursue this type of education further at ANL and local Indian community colleges and to obtain funds for energy projects. Despite the positive feedback, several difficulties were encountered. Among them are the necessity to continually modify the programs to fit diverse tribal needs, to diminish politically motivated interference, and to increase portions of the funding to involve more Native Americans.

819 **Remaining-life-depreciation concept: a regulator's view.** Fox, W.F. (Ohio Public Utilities Commision, Columbus). *Public Util. Fortn.;* **102**: No. 1, 19-21(6 Jul 1978).

The Ohio Public Utilities Commission rejects the remaining-life-depreciation concept. Its most serious deficiency is that it fails to charge to each accounting period a measure of plant consumption properly attributable to that period of use, the author says. The remaining-life method is designed to meet the first goal of depreciation accounting: to recover the original cost of the property, less salvage, over the estimated useful life of the property. The method meets this goal too well, and it does so automatically enough that a utility company might feel it has an almost divine right to recover 100% of its investment regardless of the circumstances. The author uses an illustrative case to point out four fallacies of the method—"catch-up; distortion; guesstimation; and dupery". These are discussed and are shown to be largely responsible for the Commission's staff rejecting the concept. Land rights and subaccounting are discussed also. (MCW)

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 833, 856, 1362

820 (EPA—600/9-77-041) **Energy/environment fact book.** (Department of Energy, Washington, DC (USA); Environmental Protection Agency, Washington, DC (USA)). Mar 1978. 78p. Dep. NTIS, PC A05/MF A01.

The collection of graphics and data comprises the draft of Chapter 11 of the U.S. DOE Fact Book. The focus of this chapter is on those environmental issues which, during the near and mid-term, will prove important to the rapid development of domestic energy resources. The most important energy resource during this period will be coal; the emphasis of this report is on coal. Other near and mid-term energy sources, such as nuclear, oil shale, oil, and gas are discussed to a lesser degree. Some sources, such as solar and geothermal, are scarcely touched upon because of the long-term nature of their promise. However, good references for these can be found in the "Further Reading" section at the end of the report. Five specific chapter titles center on standards and trends, alternative fuels and processes, pollution controls, health and environment, and regional issues.

821 (IS-ICP—62(Vol.1)) **Descriptive analysis of Iowa's environmental agencies. Volume One. Agency reports.** Rosenberg, R.; Miller, M.; Hadwiger, D.F. (Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.). 30 Jun 1977. 202p. Dep. NTIS, PC A10/MF A01.

This publication describes the environmental agencies which have major impact upon the use and planning of Iowa's natural resources and environment. This information is regarded as a first, but necessary, step in the analysis of the Iowa environmental planning—decision-making process.

822 **Examination of environmental policies using production and pollution microparameter distributions.** Hochman, E.; Zilberman, D. (Ben-Gurion Univ. of the Negev, Beersheba, Israel). *Econometrica;* **46**: No. 4, 739-760(Jul 1978).

The existence of pollution externalities calls for government intervention in developing policy measures that will improve social welfare. This paper suggests a method to predict and compare the short-run aggregate output, pollution, and labor input of a competitive industry facing various environmental policies. Assuming that the choice between alternative production technologies can only take place prior to the investment decision, the labor output ratios and the pollution output ratios are fixed in the short run but vary among plants; their distribution is the information used in the aggregation procedure. The performance of different environmental policies—taxes and standards—is examined and compared. 10 references.

823 **Non-traditional military uses of underground space.** Jones, L.S. (Navy Public Works Center, Great Lakes, IL). *Underground Space;* **2**: No. 3, 153-158(Apr 1978).

It is not merely coincidence that has brought about the recent surge of architectural uses of underground space; rather, it is a nationwide awakening to the reality that a return to one of man's first protective habitats offers promising solutions to some of today's significant environmental and energy problems. "Geotecture" may offer military facility planners a way to reduce life-cycle costs, conserve energy, and preserve limited real estate in a great many more ways than are presently envisioned. 15 references.

824 **Environmental policy and welfare economics.** Hjalte, K.; Lidgren, K.; Stahl, I. New York; Cambridge University Press (1977). 118p. $5.50.

Translated from Swedish by Curt Wells.

This book deals with the problems involved in trying to manage the environment. Its main purpose is to depict the control of the environment as an economic issue, and to show what economic policies should be developed to improve environmental quality. The main ideas of welfare economics necessary for this purpose are introduced, and the essential concept of the common-property resource is explained. This concept and its associated idea of market failure provide the basic framework used to analyze environmental problems and policies. A major part of the book is devoted to employing these analytic tools on a series of policy problems and their solutions. Among these are the estimation of benefits from outdoor recreation, disposable versus returnable containers, chemical pollution of water by detergents, air pollution, lead poisoning, and the general work environment. Another major part of the book is devoted to regional and international aspects of environmental protection, discussing the institutions required and the consequences for international trade. This broader view of the environmental problem is also demonstrated in the discussion of the possible relation between environmental quality and the nature of the economic system; for example, does a centralized economy provide the chance for greater safeguards against pollution. A thorough coverage of environmental economics is provided.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 851

825 (CONF-7801143—) **DOE resource recovery project financing workshop.** (Gordian Associates, Inc., Washington, DC (USA)). 17 Jan 1978. Contract EM-78-X-01-2499. 40p. Dep. NTIS, PC A03/MF A01.

From DOE resource recovery project financing workshop; Washington, DC, USA (17 Jan 1978).

On January 17, 1978, the U.S. Department of Energy's Office of Conservation and Solar Applications, Division of Buildings and Community Systems, Urban Waste Technology Branch sponsored a one-day project financing workshop to discuss the barriers to financing and implementing municipal solid waste resource recovery projects and to identify workable policy and program recommendations to overcome these obstacles. Eighteen legal/financial experts and resource recovery system company managers, together with representatives of the Federal Government (through Public Technology Inc.) first met in two separate workshop sessions to identify problems, and then gathered for a single joint session to consider various Federal policy options. The Department of Energy has combined the energy resource recovery research, development, and demonstration (RD and D) program of the former Energy Research and Development Agency with the broader responsibility of the former Federal Energy Administration to foster commercialization and implementation of promising new energy technologies. This workshop was one part of a larger effort by the Department of Energy to define RD and D and commercialization strategies to further energy recovery from municipal wastes.

826 (HCP/M8429—01) **Economic analysis of the conservation of depletable natural resources. Final report.** (Microeconomic Associates, Berkeley, CA (USA)). Aug 1978. Contract EM-75-C-01-8429. 347p. Dep. NTIS, PC A15/MF A01.

This is the final report from a study of the intertemporal allocation of natural resources arising in a market economy and, in particular, development of parameterizations by which bias in the intertemporal allocation may be estimated. The first interim report surveyed existing work in this area and noted the directions in which research seemed particularly needed. Work on two of these areas, the effects of imperfect competition and of the tax system, was begun in the first interim report and continued through the second. In addition, work on the consequences of imperfect risk markets was begun in the second interim report and continued in the present report. A second new area investigated in the second report was that of technical change, an assessment of market inducements for technical change and its consequences under different institutional arrangements. The second report also began the third phase of the study, the analysis of alternative policies, with an examination in detail of the Btu tax. This report includes analysis of the effects of imperfect risk markets and two studies that deal with issues of trade policy. One study analyzes the optimal trade policy of a large consuming nation facing competitive resource suppliers. The other examines trade policies under the threat of embargoes by resource cartels, one of the important motivations for Project Independence. A concept of flexibility is introduced and the optimum degree of flexibility is analyzed when the supply of a natural resource is affected by the probability of a large price rise from an embargo. Finally, the nature of policies which should be introduced in the face of the threat of an embargo are discussed.

827 **Substitution among exhaustible resources and intergenerational equity.** Hartwick, J.M. (Queen's Univ., Belfast). *Rev. Econ. Stud.;* **45**: No. 140, 347-354(Jun 1978).

Hartwick (American Econ. Rev., 66 (Dec. 1977)) showed that implicit in R.M. Solow's model of intergenerational equity and exhaustible resources (Rev. Econ. Studies (Symposium, 1974) 29-46) was the savings-investment rule: society should invest in reproducible capital precisely the current returns from the use of flows of exhaustible resources in order to maintain per capita consumption constant. Population was assumed to remain constant. Solow and Hartwick assumed that there was only one exhaustible resource. Beckmann (American Econ. Rev., 65, 695-99 (Sept 1975)) investigated optimal growth in models with many exhaustible resources. In this paper the case of many exhaustible resources is considered and results are derived on substitution among resources and on the nature of paths of development. One of Beckmann's results on substitution is analyzed. The approach is first to analyze efficient paths under the assumption of general savings functions and then to analyze efficient paths under the assumption of the special savings function referred to above. Results indicate the Solow's existence theorem remains valid for the case of many exhaustible resources and some light is shed on the existence of paths for production functions not of the Cobb-Douglas form. 12 references.

828 **Role of systems analysis in aiding countries facing acute food shortages.** Manetsch, T.J. (Michigan State Univ., East Lansing). *IEEE Trans. Syst., Man, Cybern.;* **SMC-7**: No. 4, 264-273(Apr 1977).

Modern systems analysis can play an important role in developing strategies and systems for reducing human misery and starvation in countries undergoing food crises. A "survival model" is

described that permits the model user to explore various strategies for managing available food as a simulated country undergoes a food crisis. Model results are presented that indicate that some strategies make much better use of available food than others and lead to significantly higher survival rates in the afflicted population. Model results suggest several specific areas where systems analysts can contribute meaningfully to the effective use of available food resources in feeding people undergoing acute food shortage.

RESEARCH AND DEVELOPMENT

REFER ALSO TO CITATION(S) 814, 839

829 (DOE/ET—0057) **FY 1978 project appraisal applications and results.** (Department of Energy, Washington, DC (USA). Div. of Power Systems). Aug 1978. 26p. Dep. NTIS, PC A03/MF A01.

The Division of Power Systems (DPS) has developed a project appraisal methodology which enables DPS to select projects with the greatest potential for achieving divisional and national energy goals. First applied in 1977, the methodology has been refined and was reapplied in March 1978. This report summarizes the results of the second application. The project appraisal methodology is outlined as are the guidelines for both data preparation and the actual appraisal session. The report also discusses the impact of the appraisal results on the division's total planning system and on the preparation of the zero-base budget. The DPS mission is to promote a smooth transition from oil and gas to alternative fuels through the development of energy conversion equipment that is environmentally sound, more efficient, and has greater fuel-flexibility than conventional or near-term technologies. Four major activities aligned within the functional organization involve combustion systems, heat engines and heat recovery, fuel cells, and advanced environmental control technology.

830 **Technology for the Third World.** Steel, M.R. (Heriot-Watt Univ., Edinburgh). *Phys. Technol.;* **9**: No. 3, 93-95(May 1978).

Since 1967, UNIDO (UN Industrial Development Organization) has been dealing in a variety of ways with the problems of the acquisition of technology by developing countries. The basic philosophy of UNIDO is that only through intense industrialization can developing countries hope to close the ever widening gap between their average annual per capita income. The author maintains that this philosophy apparently ignores the possibility that the way ahead for many countries requires the building up of an agricultural base, the sector where the bulk of the population is employed and from which it derives its food. Too much emphasis on industrialization could encourage the drift from the countryside to cities already bursting at the seams. The author summarizes these views in light of his own experiences in India and Tanzania. Much attention has been given to the question of transfer of technology from the more developed nations and, as a result of its work in this field. UNIDO has recently published the first two volumes in a series entitled Development and Transfer of Technology. The first volume is entitled: National Approaches to the Acquisition of Technology and the next: Abstracts on Technology Transfer. (MCW)

831 **Energy R and D modeling for budgetary decisions.** Chen, K.; Kirkwood, C.W.; Lathrop, J.W.; Pollock, S.M. (Univ. of Michigan, Ann Arbor). *IEEE Trans. Syst., Man, Cybern.;* **SMC-7**: No. 4, 222-227(Apr 1977).

From 7. conference on modeling and simulation; Pittsburgh, PA, USA (Apr 1976).

A top-down approach is taken to apply multiobjective decision analysis to the strategic budgetary decisions in energy research and development (R and D) planning. A model is developed for the explicit and quantitative treatment of uncertainties and project interrelationships. The model is applied to an example budgetary allocation between two coal liquefaction programs, H-Coal and Synthoil. The example demonstrates the potential appropriateness of decision analysis in energy R and D strategic planning.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 436, 666, 669, 670, 706, 711, 712, 713, 714, 715, 855

832 **Nuclear power and the proliferation issue.** Marshall, W. *Phys. Technol.;* **9**: No. 3, 115-127(May 1978).

The continuing controversy on fuel cycles and the risk of nuclear weapons proliferation and diversion of plutonium has prompted Dr Marshall to reassess the basic arguments for and against the fast reactor. He argues that a policy of incinerating plutonium in a suitable design of fast reactor would not only "lock up" most of the world's plutonium but would also drastically reduce the stockpile inevitably generated by thermal reactors. In reassessing the issues in this in-depth paper he discusses nuclear proliferation, analyzes which problems are real and which are a misapprehension, and suggests a way forward which retains the benefits of nuclear power while providing a more certain protection against undesirable proliferation.

833 **Underground storage of nuclear waste.** Russell, J.E. (Union Carbide Corp., Oak Ridge, TN). *Underground Space;* **2**: No. 2, 91-97(Dec 1977).

The objective of the National Waste Terminal Storage (NWTS) Program is to provide facilities in various deep geologic formations at multiple locations in the United States which will safely dispose of commercial radioactive waste. The NWTS Program is being administered for the Energy Research and Development Administration (ERDA) by the Office of Waste Isolation (OWI), Union Carbide Corporation, Nuclear Division. OWI manages projects that will lead to the location, construction, and operation of repositories, including all surface and underground engineering and facility design projects and technical support projects.

834 **Nuclear power stations: uneasiness about them and democracy.** Stoll, P. (Bernische Kraftwerke A.G. (Switzerland)). *Elektrizitaetsverwertung;* **52**: No. 10, 235-240(Oct 1977). (In German).

A report following a press conference at which the author, in discussing the state of the Graben 1140 MW BWR station project, also made some general observations about nuclear energy problems in Switzerland. Matters raised in the paper include legal requirements, safety and health, waste disposal problems, transportation of fuel for reprocessing and finance. The paper is intended to allay public anxiety.

835 **Long term nuclear program for Australia. Report of working party 5.** Alder, K.F.; SYMONDS, J.L. (AUSTRALIAN ATOMIC ENERGY COMMISSION RESEARCH ESTABLISHMENT, LUCAS HEIGHTS); BAKER, T.S. (STATE ELECTRICITY COMMISSION OF QUEENSLAND) (AND OTHERS). pp 84-111 of Energy 1977; towards an energy policy for Australia. Submissions of working parties. Canberra; Institute of Engineers, Australia (1977).

From Conference on energy 1977(towards an energy policy for Australia; Canberra, Australia (20 Jul 1977).

While it is difficult at this time to foreshadow a long term nuclear program for Australia, the essential ingredients of the decision-making background have been set out. The first involvement in the nuclear scene appears to be an entry as a uranium supplier in the late 1970s, though no indigenous use of uranium as a fuel is foreseen until after 1990.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 155, 440, 823

836 **Underground caverns for energy storage using superconductive magnets.** Haimson, B.C.; Hartwig, K.T.; Doe, T.W. (Univ. of Wisconsin, Madison). *Underground Space;* **2**: No. 3, 137-142(Apr 1978).

A group at the University of Wisconsin-Madison is studying the feasibility of constructing an energy-storage superconductive magnet in Wisconsin. Superconductive magnets have the potential of becoming an economically desirable alternative to pumped hydrostorage, particularly in areas where topography and water conditions do not favor hydroelectric plants. Superconductive magnets are circular solenoids that develop high radial and axial forces when charged. Bedrock must be used for the support structure of large units. The current program calls for the design of doughnut-shaped tunnels, with a perimeter of at least 100 m in diameter, and a cross-section of 5 x 15 m to 5 x 40 m, that will accommodate 10,000-MWh systems. The conductor would be attached to the bedrock by fiberflass-epoxy struts; insulation would reduce any cooling of the surrounding bedrock. Because of the stiffness of the conductor and its support structure, only limited radial deformations of the bedrock are allowed. In addition, because of the adverse effects of water on the conductor, inflows must be eliminated entirely. The development of site criteria is based on integration of detailed geotechnical field investigation and finite-element analysis. The site-evaluation program is being applied to locating potential areas for a plant to be constructed in southern Wisconsin.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 438, 945

837 (ANL/EES-CP—18) **Feasibility of district heating of northern U.S. cities by cogeneration.** Santini, D.J.; Davis, A.A.; Marder, S.M. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 19p. (CONF-780744—1). Dep. NTIS, PC A02/MF A01.

From 1. conference on energy and community development; Athens, Greece (10 Jul 1978).

This paper summarizes a study that examines the engineering and economic feasibility of providing district heating to six major northern U.S. central cities by utilizing cogenerated electrical and thermal energy from retrofit of existing power plants. The four major components of the analysis are discussed, namely: (1) demand estimation, (2) supply analysis, (3) transmission/distribution design, and (4) approximation of operations. A cost comparison to three coal-based heating alternatives is made, including (1) electricity, (2) coal gasification, and (3) coal liquefaction. In addition to costs, energy savings are illustrated for the district-heating technology. Results indicate that cogeneration-based district heating is a technology worthy of continued evaluation by the U.S. 13 references.

838 (ANL/ICES-TM—8) **Formulation of market strategies for Integrated Community Energy Systems (ICES).** (Real Estate Research Corp., Washington, DC (USA)). Apr 1978. Contract W-31-109-ENG-38. 101p. Dep. NTIS, PC A06/MF A01.

The ANL Energy and Environmental Systems Division has undertaken studies of implementation mechanisms and commercialization prospects for "integrated community energy systems." Real Estate Research Corp. was commissioned to formulate marketing strategies appropriate to the implementation of ICES in the U.S. Objectives of this assignment are to: assist ICES program managers in formulating market strategies for the acceptance and widespread application of ICES systems; provide sufficient background information on the processes of development so that marketing strategies can be suitably tailored to particular concerns and characteristics of development projects; establish an information system for identifying areas, subareas, sites, or projects with substantial growth and development activity, as potential candidates for the application of ICES; test the information system to determine its potential usefulness for identifying candidate sites; and provide recommendations on strategies and techniques that might be used in a comprehensive marketing program for application of ICES systems. Chapter 2 presents information on the development process, which is used as a framework for other elements of the report. The project information system for identifying candidate projects for ICES applications is described in Chapter 3, and that system is subjected to a limited test and evaluation in Chapter 4. Description of the characteristics of development process appears in Chapter 5, and discussion of the formulation of marketing strategies in Chapter 6, and presentation of marketing techniques as part of an ICES marketing program in Chapter 7.

CONSERVATION

REFER ALSO TO CITATION(S) 815, 823, 826, 829

839 (CONF-771245—) **Proceedings of the first national workshop on energy efficiency education through technology transfer.** Cohen, K.C. (ed.). (Department of Energy, Washington, DC (USA). Div. of Power Systems). 1977. 110p. Dep. NTIS, PC A06/MF A01.

From 1. workshop on energy efficiency education through technology transfer; Washington, DC, USA (15 Dec 1977).

PROCEED (Program for Continuing Engineering Education), with its ability to be used in traditional modes of continuing engineering education as well as to provide a new approach to updating and problem-solving on the job, is an effort which the U.S. Department of Energy should encourage and evaluate carefully in a variety of ways, especially in areas under its aegis such as energy conservation, alternative energy sources, and associated technologies. A number of specific recommendations were made to the Project as well as to the Department of Energy. Seven speeches given at the workshop were: The National Energy Problem and the Federal Response, Dr. John A. Belding; Energy Conservation Education—Major Considerations, Professor Elias P. Gyftopoulos; False Images in Engineering Education, Professor Myron Tribus; Effective Methods of Delivering Appropriate Information—A Status Report, Dr. Harvey J. Brudner; Project PROCEED—Developmental History, Professor Lawrence B. Evans; Project PROCEED—Its Learning Design, Professor Karen C. Cohen; and Project PROCEED—How It Works, Dr. C. Michael Mohr.

840 (FEA/D—77/237) **Energy efficiency improvement targets: paper and allied products industry, SIC 26.** (Federal Energy Administration, Washington, DC (USA)). Mar 1977. Contract EM-76-C-01-8624. 62p. Dep. NTIS, PC A04/MF A01.

Part D of Title III of the Energy Policy and Conservation Act (EPCA), 42 U.S.C. 6341—6346, requires that FEA establish a program to promote increased energy efficiency in United States industry. This program includes the identification and ranking of major energy-consuming manufacturing industries, the establishment of energy efficiency improvement targets for at least the ten most energy-consumptive industries, and the identification of major energy-consuming corporations within targeted industries for the purpose of reporting industry progress in improving energy efficiency. Recommendations proposed in this report for the paper and allied products group (SIC 26) includes pulp mills, paper mills (except building paper mills), paperboard mills, paper coating and glazing, envelopes, bags (except textile bags), die-cut paper, and paperboard, and cardboard. The recommended target of 12 percent reduction of total energy use by 1980 was finally set.

841 (FEA/D—77/261) **Energy efficiency improvement target in the Transportation Equipment Industry, SIC 37.** (Federal Energy Administration, Washington, DC (USA)). Jan 1977. Contract EM-76-C-01-8627. 132p. Dep. NTIS, PC A07/MF A01.

The Government of the United States in December, 1975 approved the Energy Policy and Conservation Act (EPCA), Public Law 94-163, which requires that the Federal Energy Administration (FEA) establish a program to promote increased energy efficiency in United States industry. This program includes: (1) the identification and ranking of major energy-consuming manufacturing industries, (2) the establishment of energy efficiency improvement targets for at least the ten most energy-consumptive industries, and (3) the identification of major energy-consuming corporations within those industries for the purpose of reporting industry progress in improving energy consumption efficiency. The FEA has performed the first of these requirements: it has identified the ten most energy-consumptive industries in the United States. This document presents the results of a study conducted in connection with the second of those legal requirements: a study to establish a 1980 energy efficiency target for one of the ten industries, the Transportation Equipment Industry, SIC 37: the following sections entitled: Abstract and Preface; Introduction to the Target Support Document; Draft Target Support Document (separately bound); Analysis of Industry Processes; Analysis of Motor Vehicles and Equipment Industry, SIC 371; Analysis of Aircraft and Aerospace Equipment Industries, SIC 372 and 376; Analysis of Ship and Boat Building and Repairing Industry, SIC 373; Analysis of Motorcycle and Bicycle and Miscellaneous Transportation Equipment Industries, SIC 375 and 379; and Analysis of Railroad Equipment Industry, SIC 374. The Final Target for this industry SIC 37 is unchanged from the Draft Target, namely at 16 percent improvement in energy consumption efficiency from 1972 to 1980. (MCW)

842 (HCP/M5812—01) **Vanpooling institutional barriers.** Davis, F.W.; Burkhalter, D.A. (Davis, Burkhalter and Associates Transportation Consultants, Knoxville, TN (USA)). May 1978. 146p. Dep. NTIS, PC A07/MF A01.

The current interest in van pooling has raised numerous institutional problems. This report addresses several of the more apparent state and Federal institutional issues, describes current progress in resolving the problems, and suggests alternatives for removing the inhibiting factors. The report will conclude by listing specific recommendations. The discussion of institutional issues will focus on three types of pooling. These include employer-sponsored pools, in which the company owns or leases the vehicle which transports their employees, i.e., TVA, 3M Company, and the Continental Oil Company programs; employee-owned and operated pools, in which an individual operates a van just as he would a shared-expense carpool; and third-party programs, in which a government, lease firm, or company supplies the vehicle and coordinates groups of commuters as a business activity or as a public service, such as, Commuter Computer or Pinetree Transportation of Los Angeles, Vango in Maryland, or the Knoxville Commuter Pool.

843 (NP—23198/1) **Development of building models for energy budgets for building energy performance standards. Volume 1.** Ayres, J.M.; Lau, H. (Ayres Associates, Los Angeles, CA (USA)). 30 Oct 1977. 176p. Ayres Associates, Los Angeles, CA.

Energy budgets generated by the CAL-ERDA computer program will become part of the California Administrative Code (Title 24, Energy Conservation Standards for Non-Residential Buildings) as a performance standard aimed at long-term reduction in energy consumption for heating and cooling of buildings in California. Life-cycle costs of buildings constructed according to these standards are to be compared with similar results for buildings according to earlier practice. Ayres Associates, establishing the performance standards, accomplished the effort in six tasks: survey of computer programs, development of 1974 building models, development of the Title 24 building models, review CAL-ERDA computer program outputs, differential capital cost estimates of building models, and provide consulting services to the ERCDC staff. The building types considered are small and large office buildings, small and large retail stores, public assembly building, supermarket, school/classroom, restaurant, and warehouse. Representative loca-

tions are Daggett, Los Angeles, San Diego, Sacramento, and San Francisco. Additional information in 3 appendices are 1974 Restaurant Specification, Title 24 Restaurant Specification, and Restaurant Capital Cost Estimates. (MCW)

844 (NP—23198/2) **Development of building models for energy budgets for building energy performance standards. Volume II. Appendix I. 1974 Building model specifications.** (Ayres Associates, Los Angeles, CA (USA)). 30 Oct 1977. 145p. Ayres Associates, Los Angeles, CA.

Portions of document are illegible.

Ayres Associates conducted a performance standard aimed at long-term reduction in energy consumption for heating and cooling of buildings in California. The computer-calculated energy budgets will become part of the California Administration Code (Title 24, Energy Conservation Standards for Non-Residential Buildings). This presents data for 1974 Building Model Specifications for nine buildings—small and large office buildings, small and large retail stores, supermarket, restaurant, warehouse, and public assembly buildings, and classrooms. The buildings are in representative locations at Daggett, Los Angeles, Sacramento, San Diego, and San Francisco. Volume III, Appendix II will then present parallel data for the Title 24 data. (MCW)

845 (NP—23198/3) **Development of building models for energy budgets for building energy performance standards. Volume III. Appendix II. Title 24 building model specifications.** (Ayres Associates, Los Angeles, CA (USA)). 30 Oct 1977. 147p. Ayres Associates, Los Angeles, CA.

Portions of document are illegible.

Ayres Associates conducted a performance standard aimed at long-term reduction in energy consumption for heating and cooling of buildings in California. The computer-calculated energy budgets will become part of the California Administration Code (Title 24, Energy Conservation Standards for Non-Residential Buildings). This appendix presents data calculated for the Title 24 Building Model Specifications for nine buildings—small and large office buildings, small and large retail stores, supermarket, restaurant, warehouse, and public assembly buildings, and classrooms. Representative locations are in Daggett, Los Angeles, San Francisco, San Diego, and Sacramento. (MCW)

846 (ORO—5010-3) **Development of a comprehensive community energy management plan for the City of Clarksburg, West Virginia.** (InterTechnology/Solar Corp., Warrenton, VA (USA)). 1978. Contract EY-76-C-05-5010. 313p. Dep. NTIS, PC A14/MF A01.

The present report describes the work performed for the development of a comprehensive community energy management plan (project EXIST—Energy Experiment in Saving Tomorrow). The program was supported by a cost-sharing agreement between the city and ERDA. The first objective was to establish a methodology for the development of an energy-management plan for communities. The proposed methodology comprises five phases: energy-base data by type of energy, category of users, and end uses (energy audit); local energy resources; identification and quantification of the conservation possibilities and of the opportunities for integration of local resources in the community energy-flow diagram; evaluation of the technical feasibility and energy, economic, and social impacts of integrated energy systems and development of an energy plan with recommendations for its implementation. A statistical method for analysis of patterns of energy uses and a matrical method for analysis of economic, energy, and social impact of alternative energy systems are proposed. The second objective of the program was to apply the proposed methodology to the case of the City of Clarksburg. This resulted in generation of a comprehensive Energy Management Plan delivered to the City Council of Clarksburg. The Plan proposes immediate-, near-, and long-term measures to improve the energy supply and demand position of the city. An institutional framework is also suggested for practical implementation of the Plan. It is noteworthy that some of the recommendations concerning the city services included in the Plan have already been implemented by the City with encouraging results.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 846, 875, 1425

847 (AE—3/76) **Substitution between energy and nonenergy inputs in the Netherlands, 1950—1974.** Magnus, J.R. (Amsterdam Univ. (Netherlands)). Jan 1978. 26p. Instituut voor Actuariaat and Econometrie, Universiteit van Amsterdam, 23 Jodenbreestraat, Amsterdam, The Netherlands.

The effects of the 1973 oil embargo as a physical restriction were readily demonstrated by imposing bottleneck constraints in an input-output model. It is not so easy to enlarge on a longer-term perspective. This contains the threat of a continued increase in the real costs of energy rather than of sudden disruptions of supply, and it is clear that the response to this will involve substitution. For if the popular view is that energy scarcity reduces economic growth just as cheap, abundant supplies favor it, the underlying belief is that these effects arise precisely because the economic process responds to these stimuli by adaptation. An economic model is desired that corresponds to these simple beliefs and demonstrates inter alia why output should react to variations in factor prices. This paper is limited to the substitution between factors in response to price changes without explicit consideration of the level of output. It does, however, include energy among the factors of production, and thus opens the way to introduction of non-factor inputs in the aggregate production function. Two sections present the economic model which is based on the Generalized Cobb-Douglas Cost function developed by Diewert (1973). One section discusses construction of the relevant annual aggregate data for the Dutch economy 1950 to 1974, while another is devoted to estimation problems. In the last two sections the validity of the model is assessed by fitting it to the data. Results are related to the existing literature. 29 references.

848 (DOE/EIA—0058) **Comprehensive overview of winter energy data bulletins. Winter, 1977—1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jun 1978. 413p. Dep. NTIS, PC A18/MF A01.

Winter Energy Data Bulletins (WEDB) were published by the Energy Information Administration (EIA) from November 1977 through March 1978 as periodic updates to the changing trends from November 1977 through March 1978. The information supplied by the WEDBs and supplements helped in producing a framework for Federal and State energy agencies to deal with energy related problems that affected the public throughout the winter. The WEDBs contained demand and supply information for coal, natural gas, and refined petroleum products, as well as temperature accumulations and weather forecasts. The WEDBs from November 1977 to March 1978 are included in this report and the information is summarized for coal, natural gas, and refined petroleum products.

849 **Optimal depletion of an exhaustible resource with research and development towards an alternative technology.** Davison, R. (Cranfield Inst. of Tech., Bedford, Eng.). *Rev. Econ. Stud.;* **45**: No. 140, 355-367(Jun 1978).

There has been much recent interest in the problems posed by an economy that uses an exhaustible resource for its production. It is now generally accepted that dependence on an exhaustible resource need not necessarily lead to catastrophic results. This is of course due to technical progress and the possibility of alternative energy sources. Although the literature on technical progress is sparse, it is a problem which is beginning to receive attention. In this paper Davison considers technical progress brought about by capital invested in research and development. The aim of the research and development is to increase knowledge to the level where a new "resource-independent" technology will prevail. The level at which this occurs is, however, a random variable. The existence of a finite time after which investment in research and development will cease is established, assuming the switch to the new technology has not already occurred. As the problem is solved analytically, the division of capital stock between research and development and production is clearly seen.

850 **Forecasting the demand for electric power in Poland up to 2000 and conditions for meeting this demand.** Kopecki, K. (Pol Akad Nauk). *Przegl. Elektrotech.;* **53**: No. 7, 285-289(Jul 1977). (In Polish).

The role of the electricity supply industry and electric power in the fuel and power economy of the country is discussed. Methods of long-term forecasting the demand for fuel and power and the present-day level of the fuel and power economy in Poland against the background of the world economy, the expected development of the fuel and power economy in Poland up to 2000 and the means conditioning the achievement of this development are considered, along with the development of electric power industry up to 2000 based on formerly presented considerations.

851 **Short-term energy forecasts, 1977—1978.** London; U.K. Dept. of Energy (1977). 3p.

While the longer-term growth of energy demand is strongly influenced by the level of incomes and output, the link in the short term is far from stable; and in 1977, as of October, consumption of primary fuels for energy uses ran at over 3 percent above the 1976 level. Consumption generally tends to be higher in the first half of the year, and the colder weather was also responsible for some of the increase; but on a seasonal- and temperature-corrected basis, the forecast figure of around 2 percent up on 1976 was probably close to the underlying trend. Short-term supply factors such as industrial disputes or delays in commissioning of plant, as well as unusual climatic conditions, can also produce some minor changes in the general pattern of consumption and the forecasts have to be seen in the light of these possibilities. Estimates for coal, oil, gas, nuclear, and electricity are summarized.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 840, 965

852 (DOE/CR—0003) **Budget highlights. FY 1979 budget to Congress.** (Department of Energy, Washington, DC (USA)). Jan 1978. 59p. Dep. NTIS, PC A04/MF A01.

The DOE budget for FY 1979 is described for the following mission areas: energy supply (research and technology development), energy supply (production, demonstration, and distribution), conservation, regulation, emergency preparedness, energy information, environment, basic sciences, atomic energy defense activities, and policy and management. This budget totals $12.6 billion in budget authority and $10 billion in outlays. These figures are a 22% increase in budget authority and 14% increase in outlays over the FY 1978 funding of DOE's constituent agencies. Increases center primarily on the conservation, emergency preparedness, regulation, and energy information missions. The first part of the report is descriptive; the second half consists in statistical information. (RWR)

853 (DOE/FERC—0011) **Federal Power Commission 1977 final annual report.** (Federal Energy Regulatory Commission, Washington, DC (USA)). Jul 1978. 67p. Dep. NTIS, PC A04/MF A01.

This is the 57th and final annual report of the Federal Power Commission. It was prepared so that the Congress and the public will have a full record of the Commission's history. The Commission issued annual reports every year beginning in 1920, except for a five-year period during World War II when abbreviated versions were prepared. The Commission was originally charged with the licensing and regulation of certain uses of the country's water resources, and later was given additional responsibilities, including the regulation of electric rates and services for wholesale transactions, and the regulation of natural gas pipelines and producers, all operating in interstate commerce. The total budget for the Commission in fiscal 1977 was $41,582,000. The Commission's average monthly employment during the year was 1,378. Highlights of 1977 concerning natural gas, electric power, rules and regulations, and legislation are summarized. A history of the FPC is included, followed by in-depth information on natural gas; electric power; legal aspects; and statistics in 4 appendixes. (MCW)

854 **Meeting the research needs of state regulators.** Sweet, D.C. (Ohio Public Utilities Commission, Columbus). *Public Util. Fortn.;* **102**: No. 4, 11-15(17 Aug 1978).

Utility regulators, if they are to effectively meet the challenge of rapid change, must have the tools and resources to deal with changing circumstances and issues. The author, who was instrumental in creating the National Regulatory Research Institute (NRRI), describes the origins, purposes, and present functioning of that research tool.

855 **Energy 1977; TOWARDS AN ENERGY POLICY FOR AUSTRALIA. SUBMISSIONS OF WORKING PARTIES. PROCEEDINGS OF A CONFERENCE HELD BY THE INSTITUTE OF ENGINEERS;AUSTRALIA, AT CANBERRA, 20-22 JUL 1977.** Canberra; International Atomic Energy Agency (1977). vp. (CONF-770767—).

From Conference on energy 1977(towards an energy policy for Australia; Canberra, Australia (20 Jul 1977).

Separate abstracts are included for individual papers. (LK)

856 (PNL-RAP—24) **Usefulness of alternative integrative assessment methodologies in public decision making.** Erickson, L.E.; Litchfield, J.W.; Currie, J.W.; McDonald, C.L.; Adams, R.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jul 1978. Contract EY-76-C-06-1830. 62p. Dep. NTIS, PC A04/MF A01.

Many diverse social, economic, and environmental effects are associated with each of the available energy development alternatives. The assessment of the costs, risks, and benefits of these energy development options is an important function of the U. S. Department of Energy. This task is more difficult when no single alternative is better than the others in all respects. This paper compares benefit-cost and multi-attribute utility analysis as decision aids for these more difficult and more common assessment cases. PNL has developed expertise in making these assessments through its involvement since the Calvert Cliffs decision in both the preparation of Environmental Impact Statements and the development of methods to make these statements more thorough and responsive to the spirit of the National Environmental Protection Act (NEPA). Since 1973 PNL has had continuing efforts to quantify, value, and compare all of the major factors which influence the overall impacts of energy development options. An important part of this work has been the measurement and incorporation of the relative values which community groups place on these conflicting factors. Such difficult assessment problems could be approached in many ways including the use of benefit-cost or multi-attribute utility analysis. This paper addresses the following questions: (1) Should an integrative assessment methodology be used for the overall assessment of these costs, risks, and benefits. (2) If an integrative assessment methodology is to be used, what alternative methods are available and what should be the basis for selecting a method. (3) Is it possible to use one of the available alternatives for one portion of the assessment and another for another portion of the assessment. The answers to these questions presented in this report are applicable to most public decision problems.

857 (R—2028-KF/RC) **Urban impacts of Federal policies. Vol. 2. Economic development.** Vaughan, R.J. (RAND Corp., Santa Monica, CA (USA)). Jun 1977. 176p. Rand Corp., Santa Monica, CA.

Prepared under a grant from the Charles F. Kettering Foundation.

This report is one of several in a broad study that examines Federal actions in relation to aspects of the urban economic, residential, and fiscal environment. The purpose of this study is to determine capabilities for analyzing the effects of Federal policies on urban areas. Many of the effects are not directly caused by Federal actions but are rather the inadvertent, and even undesired, side effects of policies aimed at specific social and economic goals. For analytic simplicity, the urban economy is conceived of as having three distinct but interacting sectors: (1) the private business sector, (2) the residential sector, and (3) the urban public sector. This permits consideration of the subset of Federal policies that act directly on that sector, the subset of outcomes relevant to that sector, and the interactions among sectors. This report discusses only those Federal policies that directly influence economic development. There are several limitations on the research conducted for this report: (1) no new data are presented and no new empirical analyses were undertaken; emphasis is on synthesizing past findings; (2) the scope of the study limits the level of disaggregation at which the influence of policies can be examined; to the extent that each urban area is unique, a study of Federal policies should examine those effects for each urban area, but this report has attempted to derive general conclusions, by type of urban area; and (3) rather than analyze the separate programs of each Federal bureau, agency, and administration, the study has examined aspects of the private economy upon which groups of policies act. Federal policies affecting the level, growth, and distribution of demand are distinguished from those affecting the price and availability of factors of production. 247 references.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 277, 436

858 (NP—23370) **Community projects in the hydrocarbons sector: Regulation 3056/73.** (Department of Energy, London (UK)). Dec 1977. 26p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Information on a European Economic Community Fund to promote research and development work in exploration, production, transport, and storage of crude oil and natural gas.

A major objective of the energy policy of the European Community is to improve the security of supplies of oil and gas. Member states have agreed to a joint fund to promote new technology which can contribute to this objective. The Community Projects in the Hydrocarbons Sector scheme (CPHS) has already benefited British firms. The scheme was established by the adoption of Regulation 3056/73 at the end of 1973. It forms part of the Community's energy objective to develop indigenous resources, storage of reserve stocks, conservation, and the more efficient use of energy. Interest-free loans are made to firms for selected projects which promote new technology in exploration, production, transport, and storage of hydrocarbons. The loan is normally between 30% and 40% of the estimated cost of the development work. Payment is made in stages against accounts of work completed and the loan is repayable when the project is exploited commercially. The budget allocated hitherto to the scheme has been 25 million units of account in 1974 and 1975, 28 in 1976 and 53 in 1977. The Energy Directorate-General of the EEC Commission (DGXVII), which administers the scheme, is likely to have a budget in 1978 of 35 million European units of account.

COAL

REFER ALSO TO CITATION(S) 84, 124, 125, 126, 155, 173, 407, 831

PETROLEUM

REFER ALSO TO CITATION(S) 211, 270, 278

859 Use of underground space for developing oil and gas reserves. Tarkoy, P.J. (Perini Corp., Framingham, MA). *Underground Space;* 2: No. 3, 159-161(Apr 1978).

The discovery of oil and gas reserves in the North American Arctic, especially offshore or on islands remote from the continent, is not without unique problems relative to their development, production, and transport to market. The arctic subjects all activities and facilities to its own rigorous environment. Activities in the adverse environment are affected directly by the climate; whereas facilities are affected indirectly by phenomena such as ice, ice islands, and permafrost, which result from the climatic conditions. Novel concepts of underground production, development, and transport have been proposed to minimize climatic effects on activities and eliminate indirect effects on permanent installations.

NATURAL GAS

REFER ALSO TO CITATION(S) 293, 853, 859

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 317

ELECTRIC POWER

REFER ALSO TO CITATION(S) 448, 449, 450, 451, 452, 836, 853

860 (DOE/EIA—0004/1(78)) **EIA report on 500 kWh residential electric bills in major cities, April 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jun 1978. 3p. (CRN—780608-00238). Dep. NTIS, PC A02/MF A01.

A summary is presented of residential electric bills for 40 major U.S. cities for the month of April 1978. For comparative purposes electric bills are also presented for January 1977 and 1978.

861 (DOE/EIA—0004/2(78)) **EIA report on 500 kWh residential electric bills in major cities, July 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Aug 1978. 2p. (CRN—780821-00354). Dep. NTIS, PC A02/MF A01.

A summary is presented of residential electric bills for 40 major U.S. cities for the month of July 1978. For comparative purposes electric bills are also presented for January 1977 and January, April, and July 1978.

862 (DOE/EIA—0004/3) **EIA report on 500 kWh residential electric bills for October 1977 in major cities.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Dec 1977. 3p. (CRN—771122-00008). Dep. NTIS, PC A02/MF A01.

A summary is presented of residential electric bills for 40 major U.S. cities for the month of October 1977. For comparative purposes electric bills are also present for January, April, and July 1977 and January 1976. (JSR)

863 (DOE/EIA—0009/1) **All-electric homes in the United States. Annual bills, January 1, 1977: cities of 50,000 and more.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jan 1978. 31p. Dep. NTIS, PC A03/MF A01.

This report presents information on the average annual costs for representative amounts of electricity to consumers in homes utilizing electricity exclusively for all purposes. Average annual electric bills, average charges per kWh, and average kWh consumption for these homes are shown on a nationwide basis and for each state and individual communities throughout the United States. Information contained in this report is based on data collected during the Federal Power Commission's 14th consecutive annual survey of electric-rate levels and energy-consumption patterns applicable to homes utilizing electricity exclusively for all purposes. The report includes data for 121 investor-owned utilities, 65 publicily-owned utilities, and 4 cooperatives. Annual bills are shown for 415 U.S. communities of 50,000 population and more. In addition, states with fewer than three such communities, the three largest (a total of 28), regardless of population, are included. The combined population of these 443 large cities represents more than one-third of the total population of the U.S. Cost of service to all-electric-home customers continued to rise during 1976. In the four consumption categories for which bills were calculated (15,000 kWh, 20,000 kWh, 25,000 kWR, and 30,000 kWh) weighted average bills for thte total U.S. increased about 10%; 1975 showed an increase of 9%.

864 (DOE/EIA—0037/1) **EIA report on electric retail rate increases of $366,409,000 annually during third quarter of 1977.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Feb 1978. 4p. Dep. NTIS, PC A02/MF A01. Portions of document are illegible.

This report shows that 19 electric utilities increased their retail rates by $366,409,000 annually or an average of 8.1% during the third quarter of 1977. Retail rate decreases were reported by two utilities, totaling $47,900,000 annually. In the preceding 3-month period, electric utilities reported rate increases amounting to $348,945,000 annually to all classes of customers, an average increase of 7.4%. For the same period, four utilities reported rate reductions amounting to $4,480,000. In addition to the dollar amount of the rate increases or decreases, compiled data show the number of customers affected and rate changes in residential, commercial, industrial, and "other" categories and also indicate the type of ownership of the utilities--investor-owned, cooperative, or municipal.

865 (DOE/EIA—0037/1(78)) **EIA report on electric retail rate increases of $383,607,000 annually during first quarter of 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 4p. Dep. NTIS, PC A02/MF A01.

This report shows that 33 electric utilities increased their retail rates by $383,607,000 annually or an average of 6.4% during the first quarter of 1978. Retail rate decreases were reported by two utilities, totaling $5,042,000 annually. In the preceding 3-month period, electric utilities reported rate increases amounting to $625,253,000 annually to all classes of customers, an average increase of 9.3%. For the same period, four utilities reported rate reductions amounting to $3,313,000. In addition to the dollar amount of the rate increases or decreases, compiled data show the number of customers affected and rate changes in residential, commercial, industrial, and "other" categories and also indicate type of ownership of the utilities--investor-owned, cooperative, or municipal.

866 (DOE/EIA—0037/2) **EIA report on electric retail rate increases of $624,697,000 annually during fourth quarter of 1977.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Apr 1978. 4p. Dep. NTIS, PC A02/MF A01.

This report shows that 45 electric utilities increased their retail rates by $624,697,000 annually or an average of 9.3% during the fourth quarter of 1977. Retail rate decreases were reported by four utilities, totaling $3,313,000 annually. In the preceding 3-month period, electric utilities reported rate increases amounting to $502,916,000 annually to all classes of customers, an average increase of 9.8%. For the same period, two utilities reported rate reductions amounting to $47,972,000. In addition to the dollar amount of the rate increases or decreases, compiled data show the number of customers affected and rate changes in residential, commercial, industrial, and "other" categories and also indicate type of ownership of the utilities--investor-owned, cooperative, or municipal.

867 (DOE/EIA—0040/1) **Typical electric bills: January 1, 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Aug 1978. 217p. Dep. NTIS, PC A10/MF A01.

This report provides comprehensive coverage of the cost to consumers for representative amounts of electricity used per month for residential, commercial, and industrial service in all sections of the Nation. Bills for residential electric service are repoted for five different energy consumption levels in all communities with populations of 2,500 or more. For commercial and industrial service, bills are presented for all large cities. Commercial bills are shown for five combinations of billing demands in kilowatts (kW) and monthly consumption levels in kilowatt-hours (kWh); industrial bills cover five billing demands and ten consumption levels. Long-term trends and current levels of average electric bills for residential, commercial, and industrial service for the total United States, for each State and the District of Columbia, and for nine geographic regions are tabulated. The purpose of the report is to inform the public and the industry concerning the cost of standard quantities of electricity to business and residential customers in communities throughout the United States.

868 (DOE/EIA—0041/1) **EIA issues quarterly report on national trends in electric energy resources use. First quarter, 1977.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Mar 1978. 36p. Dep. NTIS, PC A03/MF A01.

This report summarizes national trends in the use of electric energy resources for the production of electric power for the first quarter of 1977. The report indicates that electric power generation in that quarter was 5.8% above that for the first quarter of 1976. Summarizing graphs are designed to permit trends to be compared with those of the previous year. The graphs contain six units of information: net generation; fuel consumption and stockpiles; fuel deliveries; fuel costs; monthly net energy for load and monthly peak loads by regional reliability councils; sales of electric energy.

869 (DOE/EIA—0041/2) **EIA issues quarterly report on national trends in electric energy resources use. Second quarter, 1977.** (Department of Energy, Washington, DC (USA). Energy Informa-

tion Administration). Apr 1978. 38p. (CRN—780412-00156). Dep. NTIS, PC A03/MF A01.

This report summarizes national trends in the use of electric energy resources for the production of electric power for the second quarter of 1977. The report indicates that electric power generation in the second quarter was 4.7% greater than generation in the second quarter of 1976, but approximately 4.1% less than that in the first quarter of 1977. Summarizing graphs are designed to permit trends to be compared with those of the previous year. The graphs contain six units of information: net generation; fuel consumption and stockpiles; fuel deliveries; fuel costs; monthly net energy for load and monthly peak loads by regional reliability councils; sales of electric energy.

870 (DOE/EIA—0041/3) **EIA issues quarterly report on national trends in electric energy resources use. Third quarter, 1977.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Apr 1978. 36p. (CRN—780412-00157). Dep. NTIS, PC A03/MF A01.

This report summarizes national trends in the use of electric energy resources for the production of electric power for the third quarter of 1977. The report indicates that electric power generation in the third quarter was 6.2% greater than generation in the third quarter of 1976, and approximately 12.7% greater than that in the second quarter of 1977. The summarizing graphs are designed to permit trends to be compared with those of the previous year. The graphs contain six units of information: net generation; fuel consumption and stockpiles; fuel deliveries; fuel costs; monthly net energy for load and monthly peak loads by regional reliability councils; sales of electric energy.

871 (DOE/EIA—0041/4(77)) **EIA issues quarterly report on national trends in electric energy resources use. Fourth quarter, 1977.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1977. 38p. (CRN—780703-00282). Dep. NTIS, PC A03/MF A01.

This report summarizes national trends in the use of electric energy resources for the production of electric power for the fourth quarter of 1977. The report indicates that electric power generation in the fourth quarter was 0.2% greater than generation in the fourth quarter of 1976, and approximately 9.3% less than that in the third quarter of 1977. Detailed graphs are presented to permit trends to be quickly identified while enabling comparison of the trends with those of the previous year. The graphs contain six units of information: net generation; fuel consumption and stockpiles; fuel deliveries; fuel costs; monthly net energy for load and monthly peak loads by regional reliability councils; and sales of electric energy.

872 (DOE/EIA—0044) **Statistics of privately owned electric utilities in the United States, 1976. Classes A and B companies.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Apr 1978. 768p. (CRN—780323-00121). Dep. NTIS, PC A99/MF A01.

This publication presents, for the 40th consecutive year, comprehensive financial and operating information on all the large privately owned electric utility companies operating in the United States. The information has been taken from the annual reports of classes A and B electric utilities to the Federal Energy Regulatory Commission for the year 1976. Class A utilities are those having annual electric operating revenues of $2.5 million or more. Class B utilities are those with annual electric operating revenues of $1 million or more but less than $2.5 million. This data is based on information tabulated from FPC Form No. 5, monthly reports filed with the Commission by 194 privately owned electric utilities each having electric operating revenues in excess of $2.5 million annually. These monthly reports contain the results of operations and are based on unaudited operating and financial information and may include estimates. Over or under estimates are ajusted, in general, in December each year. The operating revenues reported are approximately 99% of the total operating revenues of the 212 classes A and B jurisdictional companies reporting to the Commission. The schedules contained in this report include balance sheets, income and retained earnings statements, statements of changes in financial position, capital stock and long-term debt, electric operating revenues, customers and sales by classes of service, electric operation and maintenance expenses, utility plant, physical quantities, rates of return on electric utility rate base, rates of return on common equity, interest coverage and capitalization ratios, advertising and sales expense, and sales of firm power for resale. Included for the first time in 1976 is a section detailing environmental protection facilities and actual expenses incurred.

873 (DOE/EIA—0048/2) **Gas turbine electric plant construction cost and annual production expenses, 1975. Third annual supplement.** (Department of Energy, Washington, DC (USA). Energy Information Administration). May 1978. 124p. (CRN—780412-000158). Dep. NTIS, PC A06/MF A01.

A total of 520 gas turbine electric plants owned and operated by electric utilities in the United States produced 22.436 billion kilowatt-hours during 1975, down from the net 1974 production of 32.114 billion kWh. The installed capacity of these gas turbine electric plants at the end of 1975 was 44,106 megawatts, up 11.6% from the 39,522 MW in 1974. This supplement presents detailed data for 1975 on plant investment, annual production expenses, and related information for 349 of those plants 10 MW or larger for which information was available. This report provides useful information to electric utilities, manufacturers, regulatory commissions, consultants, and others interested in the electric power application of gas turbines. The total installed capacity of the 349 gas turbine electric plants in the United States included in this report was 37,232 MW at the end of 1975, and their net generation for that year totaled 16.771 billion BWh. These plants account for approximately 84.4% of the total installed gas turbine electric plant capacity and 74.8% of the net gas turbine generation in 1975. Generation and capacity of all gas turbine electric plants, and of the larger plants are listed in this report.

874 (DOE/FERC—0012) **Con Edison power failure of July 13 and 14, 1977. Final staff report.** (Federal Energy Regulatory Commission, Washington, DC (USA)). Jun 1978. 214p. Dep. NTIS, PC A10/MF A01.

On July 13, 1977 the entire electric load of the Con Edison system was lost, plunging New York City and Westchester County into darkness. The collapse resulted from a combination of natural events, equipment malfunctions, questionable system-design features, and operating errors. An attempt is made in this report to answer the following: what were the specific causes of the failure; if equipment malfunctions and operator errors contributed, could they have been prevented; to what extent was Con Edison prepared to handle such an emergency; and did Con Edison plan prudently reserve generation, for reserve transmission capability, for automatic equipment to protect its system, and for proper operator response to a critical situation. Following the introductory and summary section, additional sections include: the Consolidated Edison system; prevention of bulk power-supply interruptions; the sequence of failure and restoration; analysis of the July 1977 power failure; restoration sequence and equipment damage assessment; and other investigations of the blackout. (MCW)

875 **Electricity supply industry in OECD countries, 1974/1976 and prospects to 1980/1985/1990.** Paris; International Energy Agency (1978). 206p. (In French and English). $9.00.

The present survey attempts to respond to some of the requirements of analytical and policy studies in the field of electricity supply and demand. The forecasts it presents include capacity by type, generation by source, and consumption by end-use sector. For most countries it covers the period to 1985, but for others, notably the United States, it looks ahead as far as 1990. The forecasts, made during 1977, were submitted by individual Member countries and do not represent an assessment by the OECD Secretariat. The Members of OECD are Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Summary data are compiled categorizing the countries into three areas: OECD North America, OECD Pacific, and OECD Europe.

876 **Electricity supply industry: achievements 1972—1975.** Paris; Organisation for Economic Co-operation and Development (1978). 82p. (In French and English). $7.50.

The information presented was obtained from replies to the OECD's 24th, 25th and 26th Electricity Supply Industry Surveys and concerns the 24 Member countries of the OECD. For the presentation of certain results, these countries have been divided into three groups: (1) OECD European area: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and United Kingdom; (2) Canada and the United States; and (3) Australia, Japan and New Zealand. These countries collectively account for roughly two-thirds of total world electricity generation and consumption. The period examined, which covers the oil crisis and the subsequent economic recession, is characterized from 1973 by less rapid increases than in the preceding periods and in certain cases even by decreases. Actual outputs are well short of the forecasts made a few years earlier.

ELECTRIC POWER GENERATION

877 (DOE/EIA—0006/20) **Hydroelectric plant construction cost and annual production expenses, 1976. Twentieth annual supplement.** (Department of Energy, Washington, DC (USA). Energy Information Administration). May 1978. 50p. (CRN—7801516-00206). Dep. NTIS, PC A03/MF A01.

This supplement presents detailed data for 1976 on plant investment, annual production expenses, and related information for 436 selected major hydroelectric plants. Of these 430 are in the contiguous U.S., three in Alaska, and three in Puerto Rico. The initial publication covered the period 1953—1956; nineteen subsequent annual supplements have been issued through 1975. At the end of the calendar year 1976, there were 1,149 hydroelectric plants owned and operated by electric utilities, including Federal and state agencies, in the United States. The 436 selected plants account for 91% of the total installed capacity and 99% of the total net generation for all hydroelectric plants in the United States. Of the reported plants, 311 are non-Federal plants of which 245 are operated under FPC licenses. With the exception of two small pumped-storage plants, the capacity of plants less than 10 megawatts are no longer reported in sufficient detail to be included. Three of the plants covered in this report are newly reported. The plant data sheets show: capacity and generation, cost of plant, production expenses, hydraulic data, and in the case of initially reported installations, plant and equipment characteristics. Two indexes of plants are included: the first lists plants by the state in which they are located, and the second lists plants alphabetically under an appropriate ownership grouping. A map of FPC power supply areas and regions is also included.

878 (EPRI-AF—664(Vol.1)) **Comparative study and evaluation of advanced-cycle systems. Final report.** Pomeroy, B.D.; Fleck, J.J.; Marsh, W.D.; Brown, D.H.; Shah, R.P. (General Electric Co., Schenectady, NY (USA)). Feb 1978. 139p. Dep. NTIS, PC A07/MF A01.

A number of advanced energy-conversion concepts are now being proposed to supplement or supersede conventional power-generation technology. They are being proposed by individuals and organizations with widely varied backgrounds, using a diversity of approaches and assumptions for predicting performance, cost, and development requirements. The work reported here was undertaken to assist EPRI in planning R and D for the utility industry by analyzing 19 of the advanced concepts on a common basis using uniform technical and economic assumptions. The concepts range from a steam cycle with an atmospheric fluidized-bed furnace to longer-term options such as magnetohydrodynamic systems. The primary purpose of this study is to define techniques for assessing the worth of these concepts to the utility industry and the nation as a whole. Three methods have been developed: levelized cost of electricity; direct-weighting method; and net-present-worth method. These measure not only the life-cycle costs associated with each power plant concept, but also the intangible attributes such as development risk and reliability. They assess the relative importance of costs and intangibles in the context of utility goals.

879 (EPRI-AF—664(Vol.2)(Pt.1)) **Comparative study and evaluation of advanced-cycle systems. Final report.** Pomeroy, B.D.; Fleck, J.J.; Marsh, W.D.; Brown, D.H.; Shah, R.P. (General Electric Co., Schenectady, NY (USA)). Feb 1978. 183p. Dep. NTIS, PC A09/MF A01.

This volume presents 3 appendices (A, B, and C) containing data dealing with the advanced power cycles evaluated. They are: Phase 1 Power Cycles Data Tabulation; Phase 2 Power Cycles—Conceptual Designs; and Summary of Power Cycle Data and Development Plans from the Energy Conversion Alternatives Study. The 19 advanced cycles and their fuels evaluated in Phase 1 and two reference cycles (last two) are: advanced steam, atmospheric fluidized-bed furnace, coal; advanced steam, conventional furnace, No. 6 oil; advanced steam, high-temperature gas-cooled reactor, nuclear; advanced steam, liquid metal fast breeder reactor, nuclear; advanced open-cycle gas turbine, recuperative, air-cooled, high Btu gas derived from coal; advanced open-cycle gas turbine, recuperative, air-cooled, No. 6 oil; advanced open-cycle gas turbine, combined-cycle, air-cooled, low-Btu gas derived from coal; advanced open-cycle gas turbine, combined-cycle, water-cooled, low-Btu gas derived from coal; advanced open-cycle gas turbine combined-cycle, water-cooled, liquid semiclean fuel derived from coal; closed-cycle gas turbine, supercritical carbon dioxide, atmospheric fluidized-bed, coal; closed-cycle gas turbine, helium atmospheric fluidized-bed, coal; closed-cycle gas turbine, helium, high-temperature gas-cooled reactor, nuclear; open-cycle plasma MHD, coal; closed-cycle plasma MHD, conventional furnace, coal; liquid-metal MHD, atmospheric fluidized-bed, coal; metal-vapor turbine, atmospheric fluidized-bed, coal; thermionic, conventional furnace, coal; fuel-cell, low-temperature, hydrogen derived from coal; fuel-cell, low-temperature, No. 6 oil; conventional steam with stack gas scrubbing (reference case for base load and midrange), coal; and simple-cycle gas turbine (reference case for peaking), high-Btu gas derived from coal. (MCW)

880 (EPRI-AF—664(Vol.2)(Pt.2)) **Comparative study and evaluation of advanced-cycle systems. Final report.** Pomeroy, B.D.; Fleck, J.J.; Marsh, W.D.; Brown, D.H.; Shah, R.P. (General Electric Co., Schenectady, NY (USA)). Feb 1978. 231p. Dep. NTIS, PC A11/MF A01.

Appendices D through H are included in this volume dealing with data compiled from the advanced cycle systems studies. They are: Details of Net Present Worth Approach; Net Present Worth With Discrete Annual Payments; Output of Net Present Worth Programs; Direct Weighting Method Power Cycle Ratings; and Direct Weighting Method: Utility Objectives and Impacts of Evaluation Criteria. (MCW)

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 125, 841, 947

881 (PB—281817) **End use energy consumption data base: series 1 tables.** (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). Jun 1978. 212p. (DOE/EIA—0014). Dep. NTIS, PC A10/MF A01.

This report presents a series of tables which categorize national energy consumption in 1974 by economic sector, by major industries within certain sectors, by end use, by fuel, and by geographic area. For the transportation sector, there is a breakout by mode of transportation. For the residential sector, there are breakouts by type of housing structure and by the income level of the residents. The data base contains consumption estimates for 1967, 1971, and 1974; the commercial sector estimates are for 1974 only. This report presents only data for 1974. The data base contains information at the national, census division, and state levels. State level data are not presently available for the residential and commercial sectors.

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 415

882 **Perspectives on energy and the nuclear alternative.** Gerard, C. (ACEC, Charleroi, Belgium). *Bull. Soc. R. Belge Electr.;* **92**: No. 3, 191-200(Mar 1978). (In French).

A general review is provided of the worldwide situation with respect to energy resources. Trends in petroleum consumption are examined and the effects of various rates of growth, ranging from 0-10%, are predicted. The economics of energy in the industrial, transportation, residential, and commercial sectors are described. Those energy sources which are available to replace petroleum to some degree, including hydroelectricity, solar energy, wind power, several types of oceanic power, and geothermal energy are summarized, and their possible contributions in terms of 'quad' equivalents are estimated. Nuclear fission and fusion are described, and the energy situation of the European Economic Community is discussed. The relative degrees of pollution and other limiting factors applicable to each alternative are tabulated.

883 **Possibilities of utilization of new non-nuclear and non-fossil energy sources.** Lehner, G. (Inst. fur Theorie der Elektrotechnik, Univ. of Stuttgart). *Kerntechnik;* **20**: No. 4, 157-168(1978).

In German and English.

Discussions of non-nuclear and non-fossil energy sources in recent years have mainly been focused on solar, geothermal, and tidal energy. Tidal energy will never play more than a negligibly small role in comparison to the total need for energy. In the short term, the same applies to geothermal energy, although the long-term prospects for this form of energy may be improved by further research. Solar energy is discussed in greater detail. It is one of three options presently available for replacement of petroleum, natural gas, and possibly coal. The other two conceivable sources are nuclear fission and fusion. Halting development of any of these options would be irresponsible. Environmental problems are unavoidable in any energy conversion process when it is applies on a large scale. Fairly detailed analyses of each energy option are provided, including indirect applications of solar energy such as wind power.

884 **Application of unconventional energy sources.** *Elektro-Monteur;* **27**: No. 6, 31-36(1976). (In German).

The two primary methods of solar energy utilization, heat extraction and direct conversion to electricity, are discussed in detail. A separate section is devoted to domestic space heating. The total capacity of geothermal power plants in the USA, Italy, New Zealand, and other countries amounted to about 1 GW in 1976. Of that capacity, the Geysers geothermal field accounted for 400 MW. Low temperature geothermal fluids are predominantly used for space heating, particularly in Iceland, Hungary, the Soviet Union, Mexico, and Japan. The potential of ocean thermal and salinity gradients is estimated to be about 40 TW. Plans for the conversion of

this energy potential are being pursued in the United States. Tidal energy is being exploited in France, where a 240 MW plant has been operating since 1966, and in the Soviet Union, where a 400 MW installation has been operational since 1969. The principles of extracting the kinetic energy of waves and converting it to electrical power are discussed. The British Government is considering a wave power plan which could be operational by 1986. The use of biomass by combustion of natural or intensely cultivated crops is described.

SOLAR

REFER ALSO TO CITATION(S) 413, 422, 432, 436, 438, 443, 448, 449, 450, 451, 452, 460, 461

885 **Solar energy and the Third World.** Agarwal, A. *New Sci.;* 77: No. 1089, 357-359(9 Feb 1978).

The Indian government plans to install 100-watt solar panels in 1 million households each year for lighting and simple domestic appliances between 1982 and 1985. The U.S. Department of Energy estimates that irrigation pumps using solar cells should become competitive with diesel pumps within 5 to 6 years. Solar energy is the only energy source some rural populations have other than wood, the use of which results in devastating deforestation. The moral obligation of the world's scientific community is to see that solar technologies be designed to reach these 700 million energy-starved people. (MCW)

GEOTHERMAL

REFER ALSO TO CITATION(S) 505, 506

OTHER

REFER ALSO TO CITATION(S) 412

ENERGY CONVERSION

REFER ALSO TO CITATION(S) 829

886 **Enhancement of nonlinear optical processes with a double-pass tight-focusing geometry.** Brueck, S.R.J.; Kildal, H. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). *Appl. Phys. Lett.;* **33**: No. 11, 928-930(1 Dec 1978).

The first use of a double-pass geometry to enhance the conversion efficiency of a parametric nonlinear process in the tight-focusing limit is reported. For third-harmonic generation in liquid—CO-O_2 mixtures using a CO_2 laser pump source, the observed enhancement is 2.5; elimination of reflection losses will result in an enhancement of 4. The double-pass geometry has also been used to obtain accurate measurements of the wave-vector mismatch Δk of the nonlinear medium.

MHD GENERATORS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 878, 879, 880

887 (FE—2363-1) **MHD-ETF design criteria.** Retallick, F.D. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). Apr 1978. Contract EF-77-C-01-2363. 171p. Dep. NTIS, PC A08/MF A01.

This document establishes criteria to be utilized for the design of a pilot-scale (150 to 300 MW thermal) open cycle, coal-fired MHD/steam plant. Criteria for this Engineering Test Facility (ETF) are presented relative to plant siting, plant engineering and operations, MHD-ETF testing, costing and scheduling.

888 (FE—2363-2(Vol.2)) **MHD ETF conceptual design. Volume II. Selection, scaling, and preliminary test plan.** Retallick, F.D. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). Apr 1978. Contract EF-77-C-01-2363. 149p. Dep. NTIS, PC A07/MF A01.

The selection procedure and the three ETF design concepts selected for preliminary evaluation are discussed. Major pilot plant components whose scaling uncertainties complicate development of an ETF design are identified and discussed in relation to their scaling characteristics and resulting impact on the most economically viable EFT. Also, the comprehensive test program at the component, subsystem, and total plant level that must be performed to achieve the objectives of performance and endurance are defined. (WHK)

889 (FE—2363-2(Vol.3)) **MHD ETF conceptual design. Volume III. Definition of concepts.** Retallick, F.D. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). Apr 1978. Contract EF-77-C-01-2363. 677p. Dep. NTIS, PC A99/MF A01.

Detailed conceptual design of the pilot coal-fired open-cycle MHD power plant is presented. System and equipment definitions are elaborated for coal handling, processing, and feeding; air and oxidant supply to combustors; seed storage and feed and plant air system; MHD hot gas power train; superconducting magnet system; MHD channel power conditioning; waste heat recovery system; steam bottoming plant and primary electrical equipment; seed processing, recovery, and regeneration; plant draft and stack gas system; major support systems; and plant instrumentation and control systems. (WHK)

890 (FE—2363-2(Vol.5)) **MHD ETF conceptual design. Volume V. Addendum.** Retallick, F.D. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). Apr 1978. Contract EF-77-C-01-2363. 142p. Dep. NTIS, PC A07/MF A01.

The major changes made to the original ETF-3 concept design are discussed, and state point data for the amended configuration are given. These changes are the result of analysis made through the conceptual design phase including a major systems iteration and, in part, reflects additional thinking regarding a multiple step facility approach. In addition, pertinent issues raised by the DOE review committees and all subsequent component analysis have been factored into the refined concept definition. Through the iteration phase of the conceptual design study, the model used in computation of the MHD generator performance has been improved. Independent comparisons have been made to substantiate the revised model. The various system and component performance parameters and their updated values as used in developing the heat and mass balances and plant performance estimates for the refined ETF-3 are listed. As a result of their modifications, the resulting plant design is slightly larger than the original ETF-3 concept. In view of this, the ETF-3 plant costs were reviewed and modified to reflect the revised concept. In addition, specific "case studies" were made that represent major system alternatives or uncertainties in important system parameters. The information presented in this addendum was in pursuit of the ETF reference design prior to DOE direction to investigate a smaller 150 MWt truncated system. This work, in conjunction with the previously developed component conceptual designs, had progressed sufficiently to allow a relatively complete plant definition and approximate cost. As such, this Volume V, when combined with Volume I through IV of the MHD ETF Conceptual Design Report, allows consideration of an alternative concept to the 150 MWt truncated system.

891 (TID—28620) **Research in coal-based magnetohydrodynamics. Quarterly technical progress report, July—September 1977.** Thomas, C.A.; Wright, R.J.; Plantz, A.R. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Research Center). 1977. 21p. Dep. NTIS, PC A02/MF A01.

A two-dimensional axisymmetric combustor model developed by Spalding has been made operational and is now being used to analyze the first and second stages of the PERC 50 MW CDIF combustor design. Work continued on development of the cyclone computer code initiated under contract by Aeronautical Research Associates of Princeton (ARAP). The ARAP code has been linked to the PERC multi-phase chemical equilibrium code to permit more detailed analysis of cyclone gasifier performance. A muffler installed on the exhaust stack of the quench tower in the 5 megawatt MHD coal gasification-combustion pilot plant has substantially reduced the noise level during operation. Eleven runs have been made to date. The burning of Montana Rosebud coal for Runs 9, 10, and 11 was made possible by the installation of a coal dryer. Pilot plant operating experience by the operating contractor now totals more than 500 hours. The data acquisition computer, a PDP 8/1, is now linked to the data analysis computer, a PDP 11/40. Plans to design, construct, and test a sub-scale CDIF combustor in the 5 MW(t) pressurized combustion facility are being formulated. During this quarter, a vertical cyclone configuration featuring top entry of fuel and air was evaluated in the atmospheric high temperature (MHD) gasifier-combustor test facility. Performance of this unit was found to be inferior to that achieved with two earlier cyclone designs. The scroll-entry cyclone was reinstalled and operated successfully with air preheated to 2900°F. A study of the technical feasibility of moving from the bench-scale to the small pilot plant level for the PERC MHD seed reprocessing scheme has been undertaken. A 50-100 lb/hr mass flow rate of K_2SO_4 appears to be the preferred pilot plant working level, consistent with existing technical and time constraints. Anticipated operating problems are described.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 891

892 (CONF-770402—4) **Experimental studies of an MHD generator in the presence of ash in plasma.** (Department of Energy, Washington, DC (USA). Div. of Magnetohydrodynamics). 1977. 47p. Dep. NTIS, PC A03/MF A01.

From The US-USSR Steering Committee for cooperation in MHD; Washington, DC, USA (13 Apr 1977).

The changes in the chemical composition and concentration of ash injected into the combustion chamber of an experimental MHD facility make it possible to simulate the basic near-wall processes that occur during the combustion of various types of fuel and at the same time significantly simplify the conditions for conducting the experiment. Consequently, beginning in 1976 a series of experimental studies was conducted at the U-02 facility, directed at solving the problems connected with the utilization of coal fuel in MHD power plants. The design concept and main parameters of the U-02 facility are described. The main characteristics of the ash injection system in the combustion chamber; the combustion chamber operating with ash; study of the slag film and its characteristics on the walls of and MHD generator channel; and cooling systems for combustion products, seed recovery, slag and ash are discussed. (WHK)

893 **On the problem of limiting energy values generated by pulsed MHD converters.** Popel, O.S.; Sinkevich, O.A. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). *Teplofiz. Vys. Temp.;* **15**: No. 2, 385-389(1977). (In Russian).

The energy characteristics of a pulsed MHD converter have been investigated in a wide range of the magnetic Reynolds numbers. Connection of the converter both to ohmic and inductive loads has been considered. Conditions of optimum correlation of the converter with ohmic and inductive loads have been obtained which provide a maximum energy removal from a flow. A criterion has been found defining a most advantageous regime of the converter operation from the viewpoint of the maximum energy output (induction storage external active load). An analysis of the limiting generated energy values has been carried out.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 888, 892

DUCT ENGINEERING AND FLUID DYNAMICS

894 (AD-A—051450) **Two-phase hartmann flows in the mhd generator configuration. Annual report, December 1976—December 1977.** Elkins, R.E. III; Kurzweg, U.H.; Trovillion, T.A.; Lindgren, E.R. (Florida Univ., Gainesville (USA). Dept. of Engineering Sciences). Feb 1978. Contract N00014-76-C-0410. 59p. NTIS PC A04/MF A01.

Since the mass density and viscosity of the liquid in a two-phase Faraday generator are much greater than those of the gas, consideration of the liquid phase alone should lead to a good description of force distribution in the generator. Averaging the motion over the liquid phase give us a set of equations which are similar to equations describing a steady flow of a fluid with spatially variable properties. Solutions of these equations are discussed first in the limit of negligible inertia and viscosity, and then in the limit of negligible inertia and non-zero viscosity. The cross stream pinch pressure gradient and its possible effects on the two-phase flow are discussed. The wall region in Faraday generators is a region of very large shear and is important in determining efficient generator operation, as is demonstrated in finite difference calculations carried out under a variety of conditions and also in an analytical boundary layer approximation which has been developed. A section has also been devoted to the possibilities of improved generator efficiency by subpartitioning the generator duct. The last section concerns similitude between two-phase generators and two-phase gravity flows. There are two velocity scales in the systems which must be scaled separately.

895 **Study on two-dimensional electric effects in a frame MHD channel.** Bityurin, V.A.; Burakhanov, B.M.; Zhelnin, V.A.; Kovbasyuk, V.I.; Kuznetsova, T.N.; Medin, S.A. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). *Teplofiz. Vys. Temp.;* **15**: No. 2, 390-398(1977). (In Russian).

Characteristics of frame MHD channels are investigated in the presence of inhomogeneous distributions of electrical conductivity and the flow rate in a cross section of a channel. A method of numerical solution in the parametric form has been developed which permits analyzing electrical properties of a channel by means of the elliptic equation solution. The effect of plasma parameters on integral characteristics of the frame channel has been considered, and the latter have been compared to the characteristics of the Faraday channel. From the data given it follows that in the range of 0.5 $(<=)$ β $(<=.)$ 5 considered the internal resistance of the frame channel is lower than in the Faraday one, and the difference increases with β increase. The experimental investigation of the frame MHD channel is carried out in the "P" channel of the U-25 installation. The "P" channel has been designed for operation with the combustion product flow rate of 25-30 kg/s mainly in the subsonic regime at a low value of the Hall field and moderate sectionalization. A good agreement has been obtained for the measured and calculated pressure distributions.

896 (SAND—78-1420) **Numerical codes for MHD flows. Quarterly technical progress report, April—June 1978. FE—6556-8.** Touryan, K.J.; Blottner, F.G.; Russo, A.J.; Taylor, J.G. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 33p. Dep. NTIS, PC A03/MF A01.

Includes executive summary, FE—6556 5-8, July 1978.

The objective of this research is to develop numerical techniques and codes for characterizing coal-combustion-operated MHD generators and diffusers. The purpose for this activity is two-fold: (1) provide the MHD Division of the Department of Energy with evaluative guidelines in selecting and exercising channel codes; (2) provide users with codes to design MHD channel/diffusers and evaluate their performance. Progress is reported on the following tasks: (1) Multidimensional channel codes: To develop codes for predicting the complete inviscid-viscous flow across the duct in an MHD generator and diffuser. (2) Slag layer studies and heat transfer analyses: To adapt an existing code to predict the stability conditions of slag layers which are driven by turbulent exterior flows and to develop a code for predicting slag layer growth. (3) Arc formation, migration, and electrode erosion: To conduct transient analyses in evaluating the inter-electrode arcing and constricted discharges from the gas to the electrode in the presence of Hall current.

897 **Review of theoretical and experimental studies of particle deposition in a turbulent flow. Deposition rate of coal slag particles on MHD channel wall.** Onda, K. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch). *Denshi Gijutsu Sogo Kenkyusho Iho;* **41**: No. 10, 807-827(Oct 1977).

In the flow of coal combustion MHD gas, the ash in coal does not completely vaporize due to the low saturation pressure. Some of the ash particles may flow axially with the gas fluid, but others may stick on the wall surface of the MHD channel to form a viscous slag layer. This slag layer plays an important role in protecting the channel materials against the corrosive, hot MHD gas. As a first step in determining a reliable particle deposition rate in MHD channels, the purpose of this review is to investigate and compare all theoretical studies and experimental results which give the steady-state deposition rate of spherical particles in a fully developed turbulent flow on a smooth surface. As results of this review the following conclusions were drawn, 1) the experimental dimensionless deposition velocities have a similar tendency over a wide range of the dimensionless particle relaxation time tau sub(+), 2) the stopping distance theory by Beal agrees best with experimental results over a wide range of tau sub(+), 3) theoretical study and experimental work are still needed for a more reliable prediction of the ash particle deposition rate on an MHD channel wall.

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 878, 879, 880

FUEL CELLS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 878, 879, 880

898 (BMFT-FBT—77-17) **Development of a prototype of a high-temperature fuel cell battery.** Holick, H.; Kleinschmager, H.; Krapf, R.; Minor, A.; Rohr, F.J. (Brown, Boveri und Cie A.G., Heidelberg (Germany, F.R.). Zentrales Forschungslabor). Feb 1976. 273p. (In German). Dep. NTIS (US Sales Only), PC A12/MF A01.

Research has been carried out with high temperature fuel cell batteries containing ZrO_2-solid electrolytes. The main object was to develop multi-cell modules and the associated joining technology as well as the development of auxiliary equipment for the operation of the batteries. Modules of 30 tube-shaped in-series connected cells and the subsequently built small battery units as well as the auxiliary equipment necessary for the reformation of natural gas have been tested successfully at working temperatures of 1000°C. Experimental cells have been operated for more than 22,000 hours at temperatures of 1000°C and under permanent load. The decrease in voltage and performance was minimal. The technical and economical data which can be expected from larger aggregates has been estimated with the help of the experimental results. Feasible application possibilities for high temperature fuel cells include energy production from gasified coal and production of hydrogen by high temperature water electrolysis.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 898

899 (EPRI-EM—833) **Fuel cell catalyst sintering studies. Final report.** Pan, Y.C.; Ciprios, G. (Exxon Research and Engineering Co., Linden, NJ (USA)). Jul 1978. 104p. Dep. NTIS, PC A06/MF A01.

The results of the second year of studies aimed at solving the catalyst surface area loss problem in phosphoric acid fuel cells are described. Phosphoric acid fuel cells use platinum catalysts dispersed as small crystallites on carbon supports. These crystallites are metastable and tend to grow to larger size (sinter) with lower surface area under the influence of surface energy forces. In the studies conducted during the previous year, a promising high surface area active carbon, North American P-100 carbon, was uncovered. Pt supported on this carbon showed minimal loss in surface area compared to other supports tested. The objectives of the current program were to exploit these promising initial results obtained with P-100 carbon support and to extend our knowledge of the mechanisms responsible for catalyst sintering. Initial findings indicated that the residual phosphorus in P-100 carbon, introduced in a H_3PO_4 pretreatment during carbon manufacture, played an important role in stabilizing support Pt crystallites. Special emphasis during the current year was placed on defining the impact of phosphorus chemistry in controlling the sintering phenomenon. Extensive sintering tests were carried out on Pt catalysts supported on P-100 and other H_3PO_4-activated carbons from different manufacturers. These tests were conducted at temperatures ranging from 130°C to 190°C and potentials ranging from +100 mV/SCE to +800 mV/SCE. The results with these supports showed good sintering resistance at temperatures below 170°C and potentials up to +700 mV/SCE. At higher temperatures or potentials, such as those representative of FCG-1 operating conditions, the catalysts sintered at measurable rates. However, it was found that the phosphorus content of these spent catalysts had decreased, and furthermore that the Pt crystallite stability was directionally consistent with the phosphorus retention data.

APPLICATIONS

REFER ALSO TO CITATION(S) 440

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 817

900 (NTISUB/C/221—403) **Technical reports of the Federal Energy Administration, cumulative through March 31, 1977.** Nicoletti, N. (comp.). (Federal Energy Administration, Washington, DC (USA); National Energy Information Center, Washington, DC (USA)). Jul 1977. 118p. (FEA/B—77/164). Dep. NTIS, PC A06/MF A01.

This bibliography updates and replaces the previous bibliography (NTISUB/C-221-402) dated April 1977. It contains citations for technical reports produced by the Federal Energy Administration (FEA) and its contractors that have been entered into the National Technical Information Service (NTIS) through March 31, 1977.

BUILDINGS

REFER ALSO TO CITATION(S) 447, 808, 823, 864, 865, 866, 867, 875

901 (ANL/CES/TE—77-9) **Unitary water-to-air heat pumps.** Christian, J.E. (Oak Ridge National Lab., TN (USA)). Oct 1977. Contract W-31-109-ENG-38. 41p. Dep. NTIS, PC A03/MF A01.

Performance and cost functions for nine unitary water-to-air heat pumps ranging in nominal size from ½ to 26 tons are presented in mathematical form for easy use in heat pump computer simulations. COPs at nominal water source temperature of 60°F range from 2.5 to 3.4 during the heating cycle; during the cooling cycle EERs range from 8.33 to 9.09 with 85°F entering water source temperatures. The COP and EER values do not include water source pumping power or any energy requirements associated with a central heat source and heat rejection equipment.

902 (CONF-771256—) **Insulation meeting: Department of Energy. Transcript of proceedings.** (Acme Reporting Co., Washington, DC (USA)). 16 Dec 1977. 69p. Dep. NTIS, PC A04/MF A01.

From Insulation meeting; Washington, DC, USA (16 Dec 1977).

A meeting was held on December 16, 1977 at the Department of Energy for the purpose of publicly discussing the important concerns raised in Congress and elsewhere about the supply, production, price, performance standards, legislation and quality control aspects of thermal insulation for buildings. Attendees at the meeting represented the DOE, insulation manufacturers, installers and retailers, consumer groups, utilities involved in retrofit programs and federal agencies such as the FTC, Dept. of Commerce, etc. A transcript of the meeting is presented. (LCL)

903 (COO—1340-60) **Weather dependency of energy demands for space heating.** Reiter, E.R. (Colorado State Univ., Fort Collins (USA). Dept. of Atmospheric Science). [nd]. Contract EY-76-S-02-1340. 8p. (CONF-780476—2). Dep. NTIS, PC A02/MF A01.

From 3. conference on application of solar energy; Huntsville, AL, USA (17 Apr 1978).

During the past two years we have developed and tested a computer model that calculates the requirements of energy for space heating by a community in its dependence on daily weather parameters, such as temperature, wind and radiation. The input requirements for the model consist of a building census that permits one to arrange the heated (or air-conditioned) structures of a community into various types according to building characteristics and occupant habit patterns. Test runs of the model in Greeley, Colorado, and Cheyenne, Wyoming, during the winter 1976/77 yielded very satisfactory results.

904 (LBL—7826) **Energy utilization analysis of buildings.** Lokmanhekim, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1978. Contract W-7405-ENG-48. 20p. (CONF-780667—4). Dep. NTIS, PC A02/MF A01.

From Symposium on solar energy; Cairo, Egypt (16 Jun 1978).

The accurate calculation of the energy requirements and heating and cooling equipment sizes for buildings is one of the most important, as well as one of the most difficult, problems facing the engineer. The fundamental principles utilized in the procedures developed by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) are explained and brief descriptions of the computer programs using these procedures are given. Such computer programs generally are capable of: simulating the thermal response of a building to all sources of heat gains and losses, accounting for all non-thermal energy requirements in the building or on the sites, translating the building operating schedules into energy demand and consumption, identifying the peak capacity requirements of heating and cooling equipment, and performing an economic analysis that would select the most economical overall owning and operating cost equipment and energy source that minimize the building's life cycle cost.

905 (LBL—7852) **Energy efficient fluorescent ballasts. Phase I, final report.** (Stevens Luminoptics Corp., Pleasanton, CA (USA)). 21 Jun 1978. Contract W-7405-ENG-48. 80p. Dep. NTIS, PC A05/MF A01.

The development of a high-frequency electronic (Stevens) ballast for fluorescent lamps is described. It is claimed that use of this ballast could reduce use energy consumption by 1.2 to 2.5 percent. The Stevens ballast has a basic efficiency of 29 percent when used with conventional lamps. With the more efficient lamps, the efficiency increases drastically. The conventional ballast and lamp has an efficiacy of approximately 60 to 63 lumens per watt (LPW). With the Stevens ballast the efficiacy raises to between 75 and 80 lumens per watt. When the Stevens ballast is utilized with the newer high efficiency lamps the efficiacy increases to 90 to 95 lumens per watt or a full 51 percent improvement over conventional coil and core ballasts and 25 percent over the best high efficiency premium coil and core ballasts. In addition to its energy savings capabilities, this high frequency fluorescent lamp ballast has the advantages that it is a true retrofit device that is directly interchangeable with the conventional coil core ballast, and it is dimmable over a wide and continuous range. (LCLC)

906 (PB—256070) **Basis for effective management of lighting energy symposium.** Ross, D.K. (ed.). (Ross and Baruzzini, Inc., St. Louis, MO (USA)). 15 Apr 1976. 646p. (CONF-7610149—; FEA/D—76/343). Dep. NTIS, PC A99/MF A01.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

Twenty papers were presented at the meeting. A separate abstract was prepared for each of 14 papers and 2 comments on papers. The remaining 6 papers were not in scope for EDB. (LCL)

907 (PB—256070, pp 49-61) **Some visual factors in reducing lighting levels.** Boynton, R.M. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

Past theories about lighting levels and visual performance are reviewed, and recent experiments which show that more light does not always mean better sight are discussed. The importance of illumination geometry, of eliminating glare, and adjusting lighting levels in working places, according to the work performed and the visual capabilities of the workers, e.g., accommodating the greater illumination required by older workers, are described. (LCL)

908 (PB—256070, pp 99-150) **Energy conservation by selective lighting standards graded in terms of task and observer characteristics.** Blackwell, H.R. (Ohio State Univ., Columbus). 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The state of knowledge on internationally acceptable lighting standards is summarized. These standards have evolved from experimental studies of the correlation between lighting levels, light distribution, visual performance, and task performance. The basic relations between task performance and the level of reference illumination (ERI) are discussed. It is concluded that by mid-1977 it will be technically feasible to measure and predetermine ERI, that the use of an ERI assessment of lighting installations will greatly increase the energy efficiency of lighting systems, and that substantial energy savings, due to implementation of lighting standards based on ERI values, should be possible with no loss in task performance. (LCL)

909 (PB—256070, pp 237-253) **Computer modelling of illumination systems.** Lewin, I. (Environmental Research Labs., Scottsdale, AZ). 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

Over the past few years, considerable advances have been made in design techniques for lighting systems, based upon the use of the computer. Owing to the almost instantaneous processing of large amounts of data, in depth investigations of numerous design alternatives can be made, allowing the selection of a system offering the optimum balance between performance, cost and energy consumption. Remarkable reductions in energy levels have been achieved, yet without appreciable sacrifice of lighting quality or visual performance. Information is presented on the automatic acquisition of photometric data, computer programs for handling outdoor and indoor lighting computations, calculation of equivalent sphere illumination (ESI), and the potential for energy and operating cost reduction through the computer design of lighting systems. (LCL)

910 (PB—256070, pp 255-294) **Necessary lighting as part of the total building design.** Stein, R.G. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

An analysis of state office buildings in Albany, N.Y. was commissioned to determine the energy savings that could be effected and at what cost. The findings relative to lighting systems are reported. Source energy consumption for lighting was reduced from 40% to 38%, or in terms of electric power from 53% to 50%. A study of lighting energy use in N.Y. city schools is also reported. It is concluded that present lighting system design is not based on actual lighting needs and has been energy wasteful, that more use should be made of natural lighting, and that lighting standards, particularly for schools, are far in excess of the light levels required. No correlation was found between increased light level and reading level attainment. (LCL)

911 (PB—256070, pp 359-366) **Managing energy vs lighting.** Clark, G.W. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The efforts of the National Electrical Manufacturing Association (NEMA) in promoting building energy management are reviewed. These efforts include the development of a data bank on building energy use; publication of booklets with guidelines on energy management, particularly as concerns lighting systems; recommendation for greater flexibility in the control of building lighting to meet user needs; and proposals for the design of new lighting systems. (LCL)

912 (PB—256070, pp 391-413) **Commercial aspects of energy conservation.** Dorsey, R.T. (General Electric Co., Cleveland). 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The economics and energy conservation aspects of improved lighting system equipment, the overall savings which can be affected by replacing a 1000-W incandescent lighting system with a 400-W Lucalox system, the advantages of new luminaires, and the willingness of the lighting industry to cooperate with U.S. government efforts to improve lighting effectiveness while decreasing energy consumption and costs are discussed. The opinion is strongly emphasized that tax incentives to replace lighting systems with more efficient sources and systems are needed to affect well-lighted productive buildings which will result in an increase in national productivity while minimizing the use of energy. (LCL)

913 (PB—256070, pp 477-493) **Applications engineer looks at visual research and conservation.** Jones, B.F. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The need for quantifiying visual performance and the variables in lighting systems which effect visual performance is stressed. The basic lighting system variables are system geometry, light flux distribution, and light flux polarization which in turn determine the Equivalent Reference Illumination, Lighting Effectiveness Factor, Contrast Rendition Factor, etc. It is concluded that research to date on visual performance has restricted itself to a determination of resolution acuity, and that research on high-efficacy lighting sources must be concerned with the physical, physiological, and psychological effects of these lighting systems on workers in order to evaluate both the energy conservation and work performance effects of lighting systems. (LCL)

914 (PB—256070, pp 495-498) **Light polarization and its effects on energy conservation.** Kahn, M. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

Present specifications for lighting systems and procedures for evaluating lighting systems are declared inadequate, difficult to apply, and of questionable validity since they are based solely on physical measurements and fail to include the psychophysiological factors involved in the effects of lighting on the eye-brain system. It is stated that use of vertical-plane polarized light always improves visual performance. The use of vertically plane polarized light improves contrast rendition, color rendition, and visual comfort and permits reduction of illumination levels with no loss in visual performance. The energy savings possible by employing vertically plane polarized light could amount to 3-billion dollars per year in the USA from lighting systems alone. It is recommended that the technical complications be taken out of lighting system specifications, and that the words "the equivalent in visual performance with the lowest energy requirement" should be included in such specifications so that the energy consumption and cost of lighting systems can be reduced while present visual performance standards are maintained. (LCL)

915 (PB—256070, pp 499-508) **Comments on the potential value of light polarization for energy conservation.** Blackwell, H.R. (Ohio State Univ., Columbus). 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The potential value of light polarization for energy conservation is briefly reviewed. It is stated that visual performance can be improved by the control of light polarization, that equipment utilizing light polarization could result in about 25% less energy consumption in lighting systems, and that present calculation procedures for establishing Equivalent Sphere Illumination (ESI) fairly reflect the effects of polarized light provided the calculations deal separately with the two planes of polarization. (LCL)

916 (PB—256070, pp 509-545) **IES and effective management of lighting energy.** Kaufman, J.E. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The activities of the Illuminating Engineering Society (IES) in promoting lighting energy conservation are reviewed, and the contents of two IES publications, "Lighting Design Procedure to Effective Energy Utilization" and "IES Recommended Lighting Power Budget Determination Procedure" are summarized. Sample calculations for a lighting power budget are included. (LCL)

917 (PB—256070, pp 547-556) **Goals and objectives of the IES regarding energy conservation.** Fisher, W.S. (General Electric Co., Cleveland). 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The policies, objectives, and activities of the Illuminating Engineering Society (IES) in producing data and disseminating information on new lighting technology which promotes energy conservation are reviewed. (LCL)

918 **Cie visual performance system.** Levy, A.W. (Natl Res Counc of Can, Ottawa, Ont). *Light Res. Technol.;* **10**: No. 1, 19-28(1978).

The International Commission on Illumination (CIE) has developed a system for evaluating the visual performance aspects of lighting. The system and its concepts are presented with special reference to lighting energy conservation. Some of the problems involved in the application of the CIE system and the data required before widespread application is possible are discussed. 20 refs.

919 **Soil as a heat source.** Neiss, J. (Lehrstuhl C fur Thermodynamik, Technische Universitat, Munich); Winter, R.F. *Elektrowaerme Int., A, B;* **35**: No. A6, 323-327(1977). (In German).

The functional and technical applications of soil-source heat pumps are described. Electronic data processing techniques permit rapid computation of soil temperatures as heat is withdrawn. Certain thermophysical data are required for such computations, particularly the thermal conductivity of the soil. Other important parameters include dry density, water content, and mineralogy. Transient temperature variations in undisturbed ground should be monitored at several points prior to other computations. Theoretical analysis has shown that the contribution of heat from the Earth's interior is negligible under most circumstances, as compared to the contributions of solar energy and atmospheric convection. Consequently, the use of a soil-source heat pump is, in reality, an indirect use of solar energy. Data are provided concerning the temperature of brine which is circulated through pipes buried in both loamy and sandy soils at various depths. Other data are given showing brine temperatures in pipes with various axial distances.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 860, 861, 862, 863, 881

920 (DOE/EIA—0067/1(78)) **Quarterly tracking system: energy using and conservation equipment in homes.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jul 1978. 20p. Dep. NTIS, PC A02/MF A01.

Information is presented on energy using and conserving equipment in homes. This information provides baseline data for monitoring the progress of improving energy conservation in U.S. residential buildings. At the request of the Department of Energy, the Bureau of Census collected and described conditions relating principally to single-family detached units, which composes approximately two-thirds of U.S. housing. Data from the 1975 Annual Housing Survey showed: 56% had storm windows on some or all windows; 61% had at least one storm door; 75% had some roof or attic insulation; and renter-occupied units have fewer energy-conserving features than do owner-occupied units. On the basis of sample surveys covering the retrofit market during the third quarter of 1977, total residential activity directed towards energy conservation included: $326 million spent on insulation affecting 818,000 properties; (1.5% of all residential units); $157 million spent on storm windows involving 391,000 properties (over 0.5% of all residential units); $31 million spent on storm doors involving 225,000 properties; and total expenditures on energy-conservation installations of approximately $500 million. Data on new single-family residences completed during the third quarter of 1977 indicated that: 51% used electrical heating systems—28% included warm air electrically heated systems; of these, 54% included heat pumps; 37% used natural gas heating systems; 9% used fuel oil heating systems; and 54% included central air-conditioning (including some natural gas systems).

921 (PB—256070, pp 7-11) **ERDA and lighting energy conservation.** Riegel, K.W. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

Energy consumption in building lighting systems, equipment and methods of operation which will reduce this energy demand without impairing working or living condition, and US ERDA activities in promoting more energy-efficient lighting are discussed. (LCL)

922 **Proceedings of the conference on improving efficiency in HVAC equipment and components for residential and small commercial buildings.** Goldschmidt, V.W.; Didion, D. (eds.). Lafayette, IN; Purdue Research Foundation (1974). 234p. (CONF-741010—P1).

From Conference on improving efficiency in HVAC equipment and components for residential and small commercial buildings; Lafayette, IN, USA (7 Oct 1974).

A separate abstract was prepared for each paper presented at the conference for the data base. (RCK)

OFFICE BUILDINGS

REFER ALSO TO CITATION(S) 843, 844, 845, 925

923 (PB—256070, pp 295-323) **Beam and diffuse daylighting, and peak power.** Rosenfeld, A.H. (Univ. of California, Berkeley); Selkowitz, S.E. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

If the top two feet of windows (above eye level) are provided with reflective Venetian blinds to bounce direct beam sunlight onto a white ceiling, lights may be switched off for more than 1000 hours yearly in 5 billion feet of commercial space in the US, saving 10,000 megawatts, mostly at times of peak demand, and saving 1/10 quadrillion Btu of resource energy yearly. Beam daylight, at 100 lumens/Watt, is more efficient than fluorescent fixtures, and can be directed up 30 feet inwards by reflective louvers (seasonally adjusted) or Venetian blinds. Lights are controlled by timed switches or photocells. Cost of reflective blinds and switches is repaid by savings in electricity within 2 to 3 years. Relatively small savings in air conditioning power are a by-product.

924 (PB—256070, pp 415-476) **Critical analysis of FEA Office lighting study HVAC energy relationships.** Spielvogel, L.G. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

A critical analysis is presented of the Ross and Baruzzini study "Energy Conservation Applied to Office Lighting." This analysis of the study points to a lack of a meaningful data base, inadequate computer programs improperly used to process the data and simulate building conditions, errors in assumptions and conclusions, and lack of review by HVAC experts of sections of the study that deal with the HVAC energy consumption as related to lighting system operation. It is concluded that the HVAC portion of the report is of no value. (LCL)

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 843, 844, 845

925 (COO—4337-1) **HEAL G-C ICES, Phase II: detailed feasibility analysis and preliminary design. Final report, Stage 1.** (Health Education Authority of Louisiana, New Orleans (USA); New Orleans Public Service, Inc., LA (USA); de Laureal Engineers, Inc., New Orleans, LA (USA); Orr-Schelen-Mayeron and Associates, Inc., Minneapolis, MN (USA); Division of Kidde Consultants, Inc., Belleville, NJ (USA)). 22 Mar 1978. Contract EC-77-C-02-4337. 183p. Dep. NTIS, PC A09/MF A01.

In this preliminary report for Phase II of Health Education Authority of Louisiana's (HEAL) ICES program, specific elements of the basic intitutional issues were readdressed, as requested by the U.S. Department of Energy. The draft environmental assessment was reassessed and updated. Thermal energy demand profiles for the major community sectors, i.e., the five institutions comprising the HEAL Complex, were refined on a month-by-month basis and resulted in establishing ICES plant systems design capacities of 121,500 pounds per hour demand and 418,175,000 pounds per year for steam; 10,000 tons demand and 38,885,000 ton-hours per year for cooling. From these values the concept of the plant was developed. The Phase I capital cost estimate was updated. Total capital cost is now indicated as $29,960,500. The Phase I operating cost estimate was updated, with that figure now $8,468,479. The Phase I financial analysis was updated, producing an estimated annual revenue level of $9,907,062.

926 (PB—256070, pp 335-357) **General Services Administration.** King, J. 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

The General Services Administration's (GSA) approach to the non-uniform task lighting concept and its efforts to effectively manage the energy expended for lighting are reviewed. The following aspects of lighting systems are discussed: psychological effects; worker safety; complexity of system design; economics; evaluation and implementation of required lighting levels; effect of light fixtures on office acoustics and speech privacy potential; and GSA's achievement in reducing energy consumption for lighting in federal buildings. (LCL)

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 843, 844, 845, 881

TRANSPORTATION

REFER ALSO TO CITATION(S) 841, 875, 881

RAILWAY

927 Role of advanced transit in the implementation of the polycentric city concept. Schneider, J.; Noguchi, T. (Univ of Wash, Seattle). *High Speed Ground Transp. J.;* **12**: No. 1, 1-22(1978).

The paper reviews the activity centers concept and examines its relationship to the public transit part of the regional development plan. Implementation problems and potentials, survey results on the status of the polycentric city concept and selected case studies in four cities are discussed.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 842, 927, 949

928 (PB—256070, pp 367-390) **Federal Energy Administration symposium: effective management of lighting energy.** Edman, W.H. (Roadway Lighting, Washington, DC). 15 Apr 1976.

From The basis for effective management of lighting energy symposium; Washington, DC, USA (29 Oct 1976).

In Basis for effective management of lighting energy symposium.

Roadway lighting is required for safety and improved traffic conditions. Statistics are presented on US roadway mileage and usage, engery consumption for roadway lighting, potential energy savings from upgrading lighting equipment, and the cost and consumption of energy by headlights and street lights in urban areas. Design considerations, capital and operating costs, the need for a "City Lighting Beam" on vehicles, and the optimization of roadway and sign visibility are discussed. It is concluded that a lighting study should be conducted for each street application, and that energy and money can be saved with proper lighting system design, operation, and maintenance. (LCL)

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 829, 875

929 (NP—23371) **Energy Audit Series, No. 2. Building Brick Industry: energy conservation and utilization.** Rose, K.S.B. (Department of Energy, London (UK); Department of Industry, London (UK)). 1977. 88p. Dep. NTIS (US Sales Only), PC A05/MF A01.

At present the brick industry in the U.K. consumes about 28 million gigajoules of conventional energy per year which is equivalent to about 1 million tons of coal per year. 80 to 90 percent of this energy consumption occurs in the kilns used to fire the bricks. After detailing energy use in the brick-making process, areas in which significant energy savings can be affected are identified. These include heat recovery from kiln exhaust gases, improved combustion by changes in equipment and in clay composition, and reduction of the mass of brick by increased perforation of the brick. Thirteen specific recommendations are made to help achieve potential energy savings. It is estimated that the brick industry in the U.K. ccould reduce energy consumption by 17 million GJ per year for an annual brick production of 14 million tons. (LCL)

930 (UCRL—13887) **Identification of 200°F or greater liquid streams in manufacturing industry.** Hamel, B.B.; Brown, H.L. (Drexel Univ., Philadelphia, PA (USA)). 15 Aug 1978. Contract W-7405-ENG-48. 68p. Dep. NTIS, PC A04/MF A01.

The process flow diagrams for 26 industrial processes used for producing chemicals, metals, glass, petroleum products, cement, plastics, motor vehicles, rubber, and paper were reviewed to identify liquid streams of 200°F or more. Based upon this review, 16 "process" industries were considered to have potential for expander application. Energy Flow Diagrams were developed for these 16 industries. Potential waste stream information; small, medium and large characteristic plant size and scaling factors; and stream flow rates for these characteristics plants were developed. Each of the process flow diagrams was reviewed for potential waste streams. An energy analysis was performed to determine the total national waste energy carried in the stream. The Energy Flow Diagrams provide an overview of the energy flow in that industry. Once the national total was determined for that stream, the fraction of energy associated with each plant size, the number of plants of that size category and the hours per year of operation were used to estimate the flow rates per hour. The results of these analyses are that the total national energy and mass flows on a per year basis were reduced to the characteristic plant levels on a per hour basis. The electrical and mechanical demand for these characteristic plants have been estimated and tabulated. These tables provide a profile of the waste streams which appear to offer potential for expander application. (LCL)

ENERGY SOURCES

REFER ALSO TO CITATION(S) 864, 865, 866, 881

MATERIALS

REFER ALSO TO CITATION(S) 840, 841, 867

EQUIPMENT AND PROCESSES

931 Making savings in thin film evaporators. Bucher, F. *Processing;* **24**: No. 6, 73-75(Jun 1978).

Evaporation is one of the most energy consuming of industrial process operations. The operating characteristics of evaporators and methods for reducing the cost and energy consumption of evaporators by changes in equipment design, use of heat recovery, and modification of operating procedures are discussed. (LCL)

932 New smelter, acid plant at Falconbridge to improve working conditions, efficiency. *Can. Min. J.;* **99**: No. 5, 34, 37, 41(May 1978).

The major change to take place in the Falconbridge complex over the last 50 years is the construction of the $83-million smelter environmental improvement project. Electric furnace technology is combined with the latest pollution control techniques to virtually eliminate the escape of pollutants into the atmosphere.

933 Cement makers: fuel savers. Vielvoye, R. *Coal Energy Q.;* No. 16, 28-33(1978).

The cement and concrete industry is one of the U.K.'s large bulk consumers of energy. The article briefly describes the industry's efforts to achieve fuel savings. Coal dominates the cement industry's fuel buying statistics and, consequently, oil makes little impact. Nevertheless, conservation continues with pulverized domestic refuse and old engine sump oil assisting in kiln-firing, and research exploring the possibilities of kiln heat being channelled into district heating schemes.

934 Fuel and energy expenditure on metallurgical production related to steelmaking efficiency. Glinkov, M.A.; Glinkov, G.M. (Moscow Evening Iron and Steel Inst, USSR). *Steel USSR;* **7**: No. 7, 420-422(Jul 1977).

It is suggested that efficiency of steelmaking processes should be calculated as the ratio of the enthalpy of the steel and the slag to the total energy consumption, taking into account previous processes and the amount of energy consumed on processing scrap. Efficiencies are calculated in this manner for converters, OH furnaces, twin-bath furnaces, and arc furnaces. Efficiency is highest for the arc and twin-bath furnaces and lowest for the OH furnace. 5 refs.

935 Prospects for combining the iron and steel industry with nuclear-industrial complexes. Voskoboinikov, V.G.; Perlov, N.I.; Vasil'ev, E.N. (Cent Res Inst of Ferrous Metall, USSR). *Steel USSR;* **7**: No. 6, 361-364(Jun 1977).

The direct use of heat from nuclear reactors in traditional iron and steel plants is not effective because of the insufficient temperature level of this heat and because external heating of large plants is uneconomic. The main approach should be to use this heat for producing reducing gases. These gases can be conveyed to the metallurgical works in the hot or cold state. Several possibilities are considered: raising the temperature of the heat-carrier leaving the active zone of the nuclear reactor, the reaction of producing gases from hydrocarbons, gasification of solid fuel, and hydrogen production from water. A scheme is proposed for a nuclear-industrial complex located near an ore field and providing, in addition to electricity, a supply of reducing gas to direct-reduction plants.

936 Additional losses due to imperfections in lamination insulation of induction-motor magnetic circuits. Abdul-Zade, E.A.; Davy-

dov, V.F.; Rogozinskaya, T.S.; Talyshinskii, P.I. *Sov. Electr. Eng. (Engl. Transl.);* **48**: No. 2, 44-48(1977).

Losses resulting from imperfections in insulation of magnetic-circuit laminations in yoke and teeth, and produced by tangential and radial fluxes, are investigated. The formulas obtained are in good agreement with experimental data.

937 (NP-tr—2032) **Heat economy in plastics processing machinery.** Ruess, F. Translated from *Tech. Rundsch.;* **64**: No. 7, 17-21(18 Feb 1972). 18p. British Library Lending Div., Yorkshire, Eng.

Methods and equipment used for heating and cooling during the machine processing of plastics are described. The heating processes include electric, hot oil, and hot water heating. Cooling is accomplished by fans and by cold water circulation. Temperature controllers for both heating and cooling are discussed. (LCL)

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 552, 553, 837, 931, 933, 935

938 **Recovering the heat of vapor condensation in urea production.** Budanov, Yu.N.; Gorskhov, V.N.; Gorlovskii, D.M.; Kucheryavyi, V.I.; Melenin, Yu.S.; Efimov, A.I. *Sov. Chem. Ind. (Engl. Transl.);* **10**: No. 4, 304-305(Apr 1978).

Translated from Khim. Prom.; No. 4, 277-278(1978).

Results are given from industrial tests of a method for recovering heat of vapor condensation. Owing to the improvements made the specific consumption of steam in the second stage desorber was reduced approximately 0.1 t and the consumption of cooling water for vapor condensation was reduced correspondingly. In addition, the load of the equipment for the thorough purification of waste effluent (first stage desorber, hydrolyzer and so forth) was reduced 20%.

939 (UCRL—13877-1) **Identification of 200°F or greater liquid streams in manufacturing industry.** Hamel, B.B.; Brown, H.L. (Drexel Univ., Philadelphia, PA (USA)). 14 Jun 1978. Contract W-7405-ENG-48. 67p. Dep. NTIS, PC A04/MF A01.

Portions of document are illegible.

The study provides industrial process and energy information for the top 4-digit SIC manufacturing industries (represented by 26 "process" industries) which represents approximately 60% of the energy consumed in the manufacturing sector. Based upon the top 4-digit industries which are represented by the 26 "process" industries, a process flow diagram is reviewed for each industry. Based upon this review, 16 "process" industries are considered to have potential for expander application. Energy flow diagrams are developed for these 16 industries. Potential waste stream information; small, medium and large characteristic plant size and scaling factors; and stream flow rates for these characteristic plants are developed.

940 **Ploughing back the energy.** Lock, J. *Processing;* **24**: No. 6, 67-68(Jun 1978).

The growth of the heat recovery equipment industry and the potential fuel savings possible by implementing heat recovery in existing industrial plants are discussed. Examples of heat recovery from incinerator exhausts, turbine exhausts, boiler blow-down, and from food industry waste heat are given. It is estimated that the equivalent of 6 million tons of coal could be saved in the U.K. by the industrial use of heat recovery systems. (LCL)

941 **Economic balancing of heat exchangers.** Harker, J.H. *Processing;* **24**: No. 6, 85(Jun 1978).

A method for performing an economic balance on a proposed heat recovery system is presented. This system involves having two heat exchangers in series; the first using low grade exhaust steam and the second, high grade process steam. The savings in energy costs must be balanced against the increased cost of equipment. For the numerical example used, the total annual operating costs are shown to be reduced to about 55% of present operating costs. (LCL)

942 (CONF-751030—13) **Is the agricultural use of waste heat from nuclear power stations a technical and economic possibility.** Schaub, T. 1975. Translation of Paper 7/16. 14p. British Library Lending Div., Yorkshire, Eng.

From International nuclear industries fair; Basel, Switzerland (7 Oct 1975).

The technical and economic feasibility of using waste heat from nuclear power plants in Switzerland to heat soils and thereby improve crop production are examined. Soil heating systems are discussed. These systems would transfer heat from the approximately 40°C cooling water to soils raising the soil temperature from 3 to 6°C. The study showed that the waste heat from nuclear power stations can easily meet the requirements on agricultural utilization in regard to temperature range and power density. Full utilization is not possible because the available power far exceeds the requirements even of large vegetable crops under Swiss conditions. The mode of operation of the nuclear power stations is a highly restrictive boundary condition, which cannot be adapted to the requirements of agricultural crops and thus cannot ensure an uninterrupted heat supply. If the need for auxiliary energy sources results, this would probably give rise to prohibitive costs. The in-soil waste heat recovery system would cost about 500,000 SwFr/acre and would not replace any of the standard cooling systems for a nuclear power plant. However, these studies indicate that economic solutions cannot be precluded from the outset. To obtain a more reliable basis for more detailed calculations and planning work, a series of tests taking into account the Swiss conditions would have to be carried out. These tests would have to be based on various disciplines, because agricultural, thermodynamic, biochemical meteorological and process engineering problems have to be solved.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 119

943 (HCP/M3764—02) **Energy conservation, waste utilization research and development plan. Appendix C.** Rofe, R.; Ganotis, C.G.; Schneider, S.A.; Yaffe, H.J. (Mitre Corp., Bedford, MA (USA)). Jun 1978. Contract EX-76-C-10-3764. 203p. Dep. NTIS, PC A10/MF A01.

The Non-Nuclear Energy Research and Development Act of 1974 specifies that the Energy Research and Development Administration (ERDA) shall conduct a comprehensive national program of basic and applied energy research and development, including the productive use of wastes and the reuse and recycling of materials and consumer products. ERDA is required to prepare a broad-based plan for this research, development, and demonstration program which presents complete justification for program elements and activities. In late April 1975, ERDA contracted with The MITRE Corporation for assistance in developing the plan as it relates to energy conservation through waste utilization. MITRE was to conduct a review of energy recovery processes, identify problems and develop recommendations for future research and development. The results of the MITRE effort are reported. This report does not include a comprehensive assessment of energy recovery technologies and research experiences, although background information on the state-of-the-art is provided. The objective was to produce a working document which would be useful to ERDA in the formulation and implementation of an R and D strategy in energy conservation through waste utilization. Information is included on wastes as fuels; energy recovery technologies; and materials recovery systems. The recommended plan for waste utilization R and D is outlined and discussed.

944 **Soft drink distribution: an energy analysis of glass bottles.** Dodson, A.J.; Wheelock, J.V. (Univ. of Bradford, Eng.). *Int. J. Environ. Stud.;* **12**: No. 2, 145-151(1978).

The energy requirement of distributing soft drinks in disposable bottles is about three times as great as for returnable bottles, provided the trippage rate is more than about ten. The energy requirement increases as the size of the bottle decreases. The use of "Brand Identity" bottles which contain additional glass also increases the energy requirement. Recycling of cullet has an energy requirement which is about the same as using disposable bottles. Consequently, the most effective method of saving energy in the distribution of soft drinks is to use returnable bottles.

MUNICIPALITIES AND COMMUNITY SYSTEMS

REFER ALSO TO CITATION(S) 846, 901

CONSERVATION SERVICES

REFER ALSO TO CITATION(S) 842

PUBLIC SERVICES

REFER ALSO TO CITATION(S) 860

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 837, 838, 854, 861, 862, 864, 865, 866

945 (SVF—50) **Toms' Effect in district heating tube systems.** Ahrnbom, L.; Hagstrand, U. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). Sep 1977. 64p. (In Swedish). Dep. NTIS (US Sales Only), PC A04/MF A01.

Toms' Effect refers to the substantial decrease in frictional drag that is obtained when small amounts of polymers of high molecular weight are added to water. The possible benefits of using

the Toms' Effect in district heating systems were studied. The influence of polyacrylamide additives on pipe pressure drop, pump efficiency, and heat transfer was investigated in a series of laboratory experiments. The friction pressure drop is considerably lowered, up to 70 percent, by the polymer addition. However, the effect decreases with time as the long molecules mechanically break down when passing through the circulation pumps. The ability of friction reduction deteriorates by every pump passage. The terminal effect is however large enough to be of interest in connection with district heating. The decomposition products are non-corrosive and prevent corrosion product deposition on heat transfer surfaces. The influence of the additives on pump efficiency is negligible. Heat transfer coefficients are lowered to some extent but function of heat exchangers will not be jeopardized. The results of the present investigation seem promising and justify further investigations. Laboratory tests on water purification from decomposition products will continue. Final judgement of technical and economical possibilities of application of Toms' Effect will be done by a full scale test in an existing district heating system.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 120, 406, 825

946 **Summary on municipal solid refuse in Italy.** Bandiera, B.G. *Termotecnica (Milan);* **32**: No. 3, 166-168(Mar 1978). (In Italian).

A classification of solid municipal refuse and data on their origin and magnitude are presented. A comparison with the situation in the USA is given. So far, only a small part of the refuse is burnt in Italy in incinerators integrated with heat recovery from flue gases.

EDUCATION AND PUBLIC RELATIONS

REFER ALSO TO CITATION(S) 818

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

947 **Alternative automobile engines.** Wilson, D.G. (Massachusetts Inst. of Tech., Cambridge). *Sci. Am.;* **239**: No. 1, 39-49(Jul 1978).

A technology assessment of various heat engines for automobile propulsion is presented covering: the spark ignition (Otto) engine; the compression ignition (diesel) engine; the vapor cycle (Rankine) engine; the Stirling engine; and the open and closed Brayton cycle (gas turbines) engines. Comparative data given include temperature ratio, thermal efficiency, power to mass ratio, exhaust emissions, and manufacturing cost. The defects of alternative engines to the spark ignition engine are clearer than their virtues, and the choice of a single best alternative is complex. Government policies with respect to the automotive industry are discussed. (PMA)

948 **Engine design series: cooling systems.** Hartley, J. *Automot. Eng. (London);* **3**: No. 2, 62-64(Apr-May 1978).

This article reviews the following aspects of cooling systems for automobile engines: the advantages of liquid cooling over air cooling; the use and effects of all-season antifreeze solutions; the mechanisms of cooling: convection, nucleate boiling, and film boiling; the heat-barrier effect in as-cast iron cylinders, and its apparent absence with aluminum cylinders; special problems of diesel engines; coolant flow patterns; thermostats and bypasses; centrifugal water pump design; sealed systems and expansion tanks; radiator configurations and materials; coolant hoses.

949 **Ambient temperature and trip length--influence on automotive fuel economy and emissions.** Eccleston, B.H.; Hurn, R.W. Warrendale, PA; Society of Automotive Engineers, Inc. (1978). 13p. (CONF-780683—1). $2.50.

From Passenger car meeting; Troy, MI, USA (5 Jun 1978).

Experimental work was done to examine the interrelationships among automotive fuel economy, ambient temperature, cold-start trip length, and drive-train component temperatures of four 1977 vehicles. Fuel economy, exhaust emissions, and drive-train temperatures were measured at temperatures of 20, 45, 70, and 100°F using the 1975 Federal test procedure and the Environmental Protection Agency's highway fuel economy test. Results showed that vehicles used for short cold-start trips consume fuel at a much greater average rate than during long trips, and the effect is magnified with decreasing ambient temperature.

SPARK-IGNITION

950 (COO—4493-3) **Improving the performance and fuel consumption of a dual-chamber stratified charge spark ignition engine. Progress report, 1 March 1978 through 1 June 1978.** Sorenson, S.C. (Illinois Univ., Urbana (USA). Dept. of Mechanical and Industrial Engineering). Jul 1978. Contract EC-77-S-02-4493. 4p. Dep. NTIS, PC A02/MF A01.

Progress in experimental and analytical research on improving the performance and fuel economy of a dual-chamber stratified charge spark ignition engine is reported. (LCL)

EXTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 947

STIRLING CYCLE

951 (DOE/NASA/1011—78/24) **Stirling engine computer model for performance calculations.** Tew, R.; Jefferies, K.; Miao, D. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jul 1978. Contract EX-76-A-31-1011. 103p. (NASA-TM—78884). Dep. NTIS, PC A06/MF A01.

To support the development of the Stirling engine as a possible alternative to the automobile spark-ignition engine, the thermodynamic characteristics of the Stirling engine were analyzed and modeled on a computer. The modeling techniques used are presented. The performance of an existing rhombic-drive Stirling engine was simulated by use of this computer program, and some typical results are presented. Engine tests are planned in order to evaluate this theoretical model.

RANKINE CYCLE

952 (COO—2633-3) **Applied studies in advanced boiler technology for Rankine cycle power systems.** Paul, F.W.; Negreanu, M.J. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Mechanical Engineering). Feb 1978. Contract EY-76-C-02-2633. 178p. Dep. NTIS, PC A09/MF A01.

A study is presented on a new rotational boiler design which has improved passive dynamic response and two-phase flow stability characteristics. A survey of small boiler manufacturers in the United States indicated that currently available designs are based on steady-state operating requirements rather than for dynamic performance. Recent work by EPA and ERDA which addressed boiler designs for mobile automotive Rankine cycle power systems showed that boilers of a monotube or multipass tube configuration design could be developed which were physically compact, but still were subject to the two-phase flow instability problem when coupled within an operating power system. The objectives of this work were to evaluate alternative boiler configurations which would improve boiler dynamic response and also have good two-phase liquid-vapor interface flow stability. The major physical design limitation of any boiler is the small external hot gas heat transfer coefficient. Such a low coefficient requires considerable design enhancements to increase the rate of energy transfer to the circulation system fluid. The rotational boiler is a physical design configuration which addresses this problem. The results of an analytic study using several mathematical model formulations showed that a rotational boiler could have a passive response time constant which was approximately one-half the magnitude for an equivalent single pass monotube boiler. An experimental prototype rotational boiler was designed, manufactured and tested, with the experimental results confirming that the experimental passive response time constants were comparable to the estimates from the analytic models. The experimental boiler operating in two-phase flow was found to be stable and responsive to external inputs. A rotational boiler configuration is a good alternative design configuration for small compact vapor generator designs based on fast transient passive response and two-phase flow stability.

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 812

953 (LBL—7522) **Test of the performance and characteristics of a prototype inductive power coupling for electric highway systems.** Bolger, J.G.; Ng, L.S.; Green, M.I.; Wallace, R.I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1978. Contract W-7405-ENG-48. 76p. Dep. NTIS, PC A05/MF A01.

Development of an inductively coupled power system for highway applications was begun in 1976. The power system was designed to provide energy to vehicles that also carry a supply of stored energy, thus providing a large measure of operational flexibility to the vehicles and reducing the necessary inventory of powered roadways. The highway power system can support the high-speed, long-range portions of driving cycles, while the stored energy can meet the requirements of driving on non-powered streets. The system thus has been referred to as a "dual-mode" system because of the use of the two sources of energy. The results of testing a prototype coupling are presented. No physical contact between the vehicle and the power source is required, i.e., the coupling magnetically links the power system of the vehicle to a power source in the roadway (inductive coupling). Tests were performed to determine the magnetic force and flux distribution, electrical characteristics, thermal efforts and acoustic noise. The test equipment and methods are discussed. The tests confirmed the technical feasibility of this type of non-contacting electrical power coupling, and demonstrated that its components are suited to ordinary materials and manufacturing processes. The test results were found to be consistent with expected characteristics in all important respects.

954 Potential of electric vehicles in the public transport sector. Paper No. 7789. Jordan, J. New York; Electric Vehicle Council (1977). 22p. (CONF-770488—2). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

In order to demonstrate the practicality of the high performance battery electric in urban areas, South Yorkshire Passenger Transport Executive has undertaken an extensive evaluation program. The operational responsibility encompasses the cities of Sheffield, Rotherham, Barnsley and Doncaster within the British heavy industrial and steel belt. All four British battery electric buses, of differing design concepts, are being utilized. They are the Chloride, Silent Rider, the Lucas Electric Midibus and two electric buses of similar size to the Lucas bus built by Crompton Limited in Wales. An assessment was made of the potential of battery driven vehicles in the passenger transit sector. Electric buses were capable of meeting the performance demands of existing timetabling on busy urban routes within the South Yorkshire Metropolitan area.

955 Electric transportation in environmentally planned city of tomorrow. Paper No. 7788. Watkins, B. New York; Electric Vehicle Council (1977). 10p. (CONF-770488—3). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

A discussion is given of the operation of the electric monorail trains at Disneyland and Walt Disney World. The all-electric trains are powered by eight 600 V dc motors and use an air suspension system providing excellent riding qualities. A key factor in the overall efficiency is the loading and unloading technique in which the passengers step onto a moving circular platform which is synchronized to the speed of the vehicles being loaded. (PMA)

956 Trolly coaches today and in the future. Paper No. 7785. Smith, C.F. New York; Electric Vehicle Council (1977). 11p. (CONF-770488—6). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

In the 1940's and 1950's, trackless electric trolleys were widely used in US and European cities. The availability of automobiles and gasoline in the post World War II era caused the demise of the trolley bus. Today, due to petroleum conservation needs, the noise and pollution caused by automobiles, and increasing traffic jams, renewed attention is being given to electric vehicle transport. A comparison between battery driven buses and trolleys with overhead catenaries for regular routed municipal transport shows several advantages of trolleys. The characteristics of a modern chopper-controlled trolley bus are discussed, and a scenario for future developments is presented. (PMA)

957 Electrifying the Burlington Northern Railroad. Paper No. 7780. Craven, E.R. New York; Eiectric Vehicle Council (1977). 17p. (CONF-770488—8). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

The increased cost of petroleum fuels, the projected prospect of a continual shortage of crude oil for years to come, and the question of how long the supply will last have caused renewed interest in electrifying railways. Recent technology advancements in the field include the ac rectifier locomotive, thyristor propulsion control, individual axle wheel slip control, and vacuum circuit breakers. The benefits of railroad electrification are: reduced locomotive maintenance costs; longer life (30 years for electric vs 15 years for the diesel); increased reliability of service; some increase in line capacity; overload capability for acceleration; more tractive effort; and more stable long-term energy costs. (PMA)

958 Support systems for electric transit. Paper No. 7772. Gowing, M.F. New York; Electric Vehicle Council (1977). 9p. (CONF-770488—10). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

While supplying power to electric vehicles from overhead wires may be controversial in respect to city streets, the catenary system has been adopted throughout the world as the basic support system for electrified railways, including a great portion of the subclassification identified as rapid transit. The versatility of catenary systems is undoubtedly its greatest feature—it has been used for years to supply electric power to slow-moving mine haulage equipment, while in some foreign countries electric trains powered from an overhead catenary approach speeds of 200 miles an hour. Catenary construction is readily adaptable to direct or alternating current and to high and low voltages.

959 Development of an Intermediate Capacity Transit System (ICTS). Paper No. 7770. Giles, R. New York; Electric Vehicle Council (1977). 11p. (CONF-770488—11). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

The objective of the ICTS program is the development and implementation of a transit mode which offers a high degree of community acceptance and high service levels for urban applications in the capacity range of 5,000 to 20,000 pphpd. Elevated and at-grade guideway will be used as much as possible in lieu of underground construction to reduce system capital costs. Primary emphasis on urban integration considerations has led to stringent requirements for wayside noise, guideway section and station length. Features of the ICTS system include steel wheel on steel rail suspension, steerable trucks, linear induction motor (LIM) propulsion, and moving-block train control. The Ontario Provincial Government has funded UTDC for a three year $55.5m development program, to design, construct and test a prototype system. A Canadian-led development team has been established. Work on the prototype phase began in September 1976 with completion targetted for late 1979.

960 Department of Energy, the energy fund, the electric car, a message . . . . Paper No. 7762. Beaumont, R.G. New York; Electric Vehicle Council (1977). 16p. (CONF-770488—12). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

Two suggestions are made to ameliorate the cumulative energy shortages faced by the US: (1) a ten-cent per gallon gasoline tax to be placed in an energy trust fund to develop new energy sources and (2) the widespread use of electric-powered vehicles. Several beliefs regarding electric vehicles are attacked as myths: (1) there is insufficient power to recharge millions of electric vehicles; (2) electric cars will only transfer pollution from roadways to utility plants; and (3) electric cars cost too much and are unsafe. (PMA)

961 Range improvement from regenerative braking on the Copper Electric Town Car. Paper No. 7756. Miner, D.K. New York; Electric Vehicle Council (1977). 5p. (CONF-770488—14). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

The Copper Electric Town Car, a small two-passenger prototype automobile suitable for use in urban and metropolitan areas, was designed and built in 1974 as a prototype project of the Copper Development Association Inc. (CDA). It was introduced to the press and to U.S. government officials in Washington, D.C., in May of 1975. The data sheet given reports on design improvements that were made on the Copper Electric Town Car since then and describes its present performance. Topics discussed include speed control, regenerative braking, electric batteries, overall drive system, ride and handling, and range and performance. Acceleration time from 0 to 30 mph is now 8.8 sec as opposed to the original 11.8 sec. Range at a steady 40 mph has increased from 80 to 103 miles. Range for the SAE J227A Schedule D test has increased from 34 to 47.9 miles, and with regenerative braking to 54.5 miles.

962 FIAT electric city car prototype. Paper No. 7755. Brusaglino, G. New York; Electric Vehicle Council (1977). 24p. (CONF-770488—15). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

The electric vehicles represent an important research activity in FIAT. One of the themes was the development of a two seater city car prototype with properly designed body. The main purpose was to define a vehicle capable of meeting the multiaspect requirements of a comfortable and easy driving-handling-parking and suitable performance for urban operation in level or hilly routes. The general concept is in accordance to near-future solution of the electrical power equipment, both for propulsion and on-board storage system. The propulsion system consists in a separately excited high specific power dc motor fed by transistor double chopper; a Ni-

Zn battery is provided for on-board storage equipment. A technical description and results of on-the-road tests are reported.

963 Bell system applications. Paper No. 7752. McDougall, J. New York; Electric Vehicle Council (1977). 27p. (CONF-770488—17). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

A discussion is given of the efforts of the Bell Telephone System to determine if electric vehicles could be used in reasonable quantities. Current vehicle use data showed typical range requirements of 15 to 75 miles and a payload of 500 to 1,800 pounds. Ten US Post Office ¼ ton Electrucks were obtained and tested with the following results: poor performance on hills when the battery is low; poor heating and defrosting in winter; and low driver acceptance. (PMA)

964 Electric vehicle industry. Paper No. 7703. Ironside, L. New York; Electric Vehicle Council (1977). 19p. (CONF-770488—19). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

A discussion is given on the development and use of electric-powered vehicles in the United Kingdom with respect to government policies and socio-economic factors. Topics considered include: vehicle and fuel taxation; environmental impact; urban traffic; feasibility; research efforts; and vehicle insurance. It is concluded that governments, through their fiscal, industrial, and transport policies, can do much at this stage to allow for the wider use of electric vehicles in the community and that public acceptance of battery-powered vehicles is necessary. (PMA)

965 Future of electric vehicles. Paper No. 7702. McCormack, M. New York; Electric Vehicle Council (1977). 7p. (CONF-770488—20). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

A discussion is given of some of the provisions of the Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976. The law is intended to provide the information the US needs to build an infant technology to a point where it can make a significant contribution to conserving energy. The law provides a loan guarantee program for research and development and for small businesses that will manufacture and sell electric vehicles. (PMA)

966 Alternates to the chopper for electric vehicle speed control. Paper No. 7742. Von Seggern, R.D. New York; Electric Vehicle Council (1977). 11p. (CONF-770488—21). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

Applications for electric powered vehicles are many and varied. Vehicle types that do not require the finite control of motor speed as does a fork lift are considered. Most vehicles for personnel transport and material hauling can be successfully speed controlled by step switching. Various methods of motor speed control other than choppers are discussed. Good efficiency can be achieved with non-chopper controllers and, in some instances, exceed the efficiency of the chopper. The methods discussed provide an economical and practical means for motor control on electric vehicles. The power controller and drive train is one area where cost and efficiency must be carefully analyzed for the optimum system. On one end, the simple step resistor may not be the answer because of efficiency and, at the other end, the chopper may be too expensive. Field control, transmissions, battery tapping, and multi-motor drives are considered.

967 Electric vehicles: the long road shortens. Paper No. 7730. Zachau, L.D. Jr. New York; Electric Vehicle Council (1977). 9p. (CONF-770488—23). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

A discussion is given of two items which should be explored when comparing the two basic types of fork trucks (electric or internal combustion engine powered) relative to fuel usage. The cost of electric fuel vs. fossil fuel is a factor and should be carefully analyzed. The operating cost using electric fuel is approximately ⅓ the cost of using fossil fuel. The other item, however, which should be emphasized, is that electric trucks do cost more initially. This additional cost factor, however, can be justified when all other considerations are carefully examined. In addition, battery performance is an area where technology developments have shown substantial strides over the years.

968 Automatic testing of electric vehicle drives. Paper No. 7746. Pacey, K.; Edwards, J.B. New York; Electric Vehicle Council (1977). 29p. (CONF-770488—26). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

Electric vehicle propulsion systems exhibit specific energy consumption levels which vary with the duty cycles and service conditions to which they are subjected. It is not normally possible to derive representative data from simple laboratory tests or by calculations based on individual component performance. Therefore, until recently, the development of a new traction drive has involved three distinct stages: (1) preliminary testing on a simple laboratory dynamometer; (2) installation of the drive in a vehicle for evaluation under artificial duty cycle conditions on the test track; and (3) monitoring of drive system performance in an actual service environment. The above procedure is costly both in terms of development time and manpower and material resources. A report is given on new techniques for the automatic testing of battery powered traction drives. The object of this activity is to eliminate stages (2) and (3) so that all performance tests may be carried out in the laboratory. The automatic test-bed, termed a laboratory "Vehicle Simulator," consists essentially of a conventional thyristor-controlled, variable-speed dynamometer which, together with the traction drive under test, is computer controlled in such a way that the drive experiences the same duty cycle as would a unit in a service vehicle.

969 Design of electric commercial vehicles for production. Paper No. 7749. Harding, G.G. New York; Electric Vehicle Council (1977). 10p. (CONF-770488—31). $1.00.

From Electric vehicle exposition and conference; Chicago, IL, USA (26 Apr 1977).

Development of high performance electric vehicles has been pursued both by simple conversions from standard gasoline vehicles, and by designing a purpose-built vehicle in the form of a taxi incorporating novel features. By combining the lower cost of the former method with the greater efficiency of the latter, the Mark III Lucas electric vehicle was evolved based on a standard van, providing 1 ton payload capacity. The compact drive package can be fitted to a variety of vehicles at the initial manufacturing stage. Some of the implications for distribution and servicing of quantity-produced electric vehicles are considered.

970 Electric auto manual. Laski, W.V. (ed.). San Jose, CA; Electric Auto Association (1977). 48p. $6.00.

A manual is presented giving practical information on the building of electric-powered vehicles. Topics discussed include: (1) planning to build an electric vehicle; (2) dc motors; (3) electric batteries; (4) battery chargers; (5) speed controllers; (6) electronic controllers; (7) converting a VW or Fiat; (8) converting various other compacts; (9) converting a bicycle; and (10) converting a motorcycle. (PMA)

971 (NP-tr—2023) **Effect of efficiency on the operating range of electric vehicles.** Goerlach, U. Translated from *Elektrotech. Z., A;* 94: No. 11, 632-636(1973). 20p. British Library Lending Div., Yorkshire, Eng.

Apart from the drag and rolling friction inherent in a given vehicle, efficiency of the drive greatly influences battery load and operating range. This is particularly so in the case of cyclic loading with frequent acceleration and braking. Drive efficiency is, however, dependent on many different factors which make even an approximate determination very difficult. A method is described in which the drive is represented by an equivalent circuit diagram and mechanical quantities replaced by electrical equivalents. This allows a system of equations to be derived, permitting consistent mathematical treatment of the drive for any arrangement of the drive elements preferred, and losses in the system can be determined. Optimization of the drive as regards component rating can then be carried out on computers. An equivalent circuit diagram was set up for a vehicle having a dc motor drive with external excitation and electronic control. Losses and efficiencies for the whole of the drive system were calculated and comparison with test figures shows good correlation. Some possibilities for improving drive efficiency are discussed. By logical application of the available knowledge an increase in operating range of up to 25% could be obtained solely by a reduction of drive losses.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 965

VEHICLE DESIGN FACTORS

972 (CONF-780247—1) **Improvements in automotive fuel economy.** Borcherts, R.H.; Stadler, H.L.; Brehob, W.M.; Auiler, J.E. (Ford Motor Co., Dearborn, MI (USA)). 1978. 33p. Ford Motor Co., Dearborn, MI.

From Meeting for the advancement of science; Washington, DC, USA (16 Feb 1978).

Significant improvements in automotive fuel economy can be obtained by reductions in weight, aerodynamic drag (better streamlining) and rolling resistance (tire improvements) as well as improvements in engine and powertrain efficiency. As applied to a six-passenger 3700 lb present day vehicle powered with a 250 CID six-cylinder engine through an automatic transmission, the improvements in EPA M/H fuel economy for 1% reductions in either weight, aerodynamic drag or rolling resistance are projected to be 0.75%, 0.35% and 0.28% respectively. This is under the constraints of constant performance and equal emissions. The extent to which large changes in these parameters can be obtained resulting in significant improvements in fuel economy depends not only upon solving manufacturing and technical problems related to costs but also upon government regulations and customer acceptance in the marketplace. If large reductions in these parameters could be accomplished along with realistic improvements in engine and powertrain efficiency, significant improvements in fuel economy could be achieved.

ENGINE-TRANSMISSION MATCHING

973 Overdrive for automatic transmissions. *Automot. Eng. (London);* 3: No. 2, 92(Apr-May 1978).

The benefits derived from the fitment of an overdrive unit to a vehicle with a manual gearbox are well recognized, so that the current emphasis on reducing fuel consumption and noise has led to increased interest in the adoption of overdrives. Until now, however, these advantages have not been available to users of automatic transmissions, as a more complex control system than becomes necessary to ensure that operation of the overdrive does not conflict with the normal function of the automatic transmission, and that the additional ratio will be provided under the optimum conditions. This article describes an overdrive system using a conventional epicyclic overdrive unit fitted behind the gearbox or at the axle and which has a control circuit arranged to give a gear shift pattern which maximizes fuel economy without detriment to performance.

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 976

974 Compact gas generator for fuel gasification aboard motor vehicles. Frie, W.; Henkel, H.; Kostka, H.; Kuesebauch, W.; Michel, A.; Paul, B.; von Szabo, E. (Siemens, Forschungslab, Erlangen, Ger). *Siemens Forsch.- Entwicklungsber.;* 7: No. 2, 53-56(1978).

A gas generator suitable for motor vehicles has been developed which converts liquid to gaseous fuel by partial oxidation with air. The reaction proceeds nearly soot-free and its temperature is self-stabilizing. Test bed meaurements of an engine-gas generator combination under low and medium load conditions show that in comparison with a gasoline engine the specific fuel consumption is reduced by 15% and the NO/sub x/ emission by 93%. A cost benefit analysis revealed that for an NO/sub x/ limit of 0.25 g/km (0.41 g/mile) the gas generator-engine combinations will become superior to the stratified charge engine, the diesel engine and the three-way catalyst system above 5000 km per year.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 949, 974

NITROGEN OXIDES

975 Exhaust emissions from heavy-duty trucks tested on a road course and by dynamometer. Kennedy, G.J.; White, J.T. III; Springer, K.J.; Ingalls, M.N. (US EPA). *SAE Prepr.;* No. 750901, 1-20(1975).

This is a summary compilation and analysis of exhaust-emission results and operating parameters from forty-five heavy-duty gasoline and diesel-powered vehicles tested over a 7.24-mile road course known as the San Antonio Road Route (SAAR); and, for correlative pruposes, on a chassis dynamometer. Exhaust emissions expressed as grams per pound of fuel, showed that the diesels emitted less than the controlled gasoline vehicles, which in turn emitted less than the pre-controlled gasolines for both HC and CO. For NO/sub x/, the results were just the opposite, with the pre-controlled gasoline vehicles emitting least, followed by the controlled gasolines, and then by the diesels. In terms of grams per ton-mile, the comparative levels of emissions were in the same order as those expressed in terms of grams per pound of fuel, with the exception of NO/sub x/, which showed the controlled gasoline vehicles emitting the least, followed by the pre-controlled gasolines, and then by the diesels.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 975

HYDROCARBONS

REFER ALSO TO CITATION(S) 975

ALTERNATIVE FUELS

976 (FAA-RD—77-147) Design, fabrication, and testing of a full-scale breadboard nitrogen generator for fuel tank inerting application. Final report. Manatt, S.A. (AiResearch Mfg. Co., Torrance, CA (USA)). Sep 1977. 128p. NTIS.

Aircraft fuel tank ullage may contain a mixture of fuel vapor in air that presents a fire and explosion hazard. This hazard can be eliminated if the air is replaced by an inert gas containing insufficient oxygen to allow ignition. Fuel tank inerting systems using onboard storage of liquid nitrogen to supply the inert gas were demonstrated by the FAA and others and were retrofitted into some U.S. Air Force transport aircraft. Tests by NAFEC and the Air Force showed that fuel ullage oxygen concentration must be reduced to 9 percent or less to protect against ignition sources. The use of hollow fiber permeable membranes in an onboard inert gas generator (IGG) fuel tank inerting system was shown to be a feasible alternative to systems using stored liquid nitrogen, which must be periodically replenished. A program to optimize the permeable membrane geometry; generate data required for system design; and to design, fabricate, and test full-scale breadboard permeable membrane air separation modules was conducted using the McDonnell-Douglas DC-9 aircraft as a design baseline. Results of membrane development, full-scale breadboard module design, and testing are reported; a preliminary design is presented for a hollow fiber permeable membrane IGG system for the DC-9; and ownership considerations for the airborne system design, including a life cycle cost analysis, are discussed.

977 (HCP/W3683—18) Methanol fuel modification for highway vehicle use. Final report. Keller, J.L.; Nakaguchi, G.M.; Ware, J.C. (Union Oil Co. of California, Brea (USA). Research Dept.). Jul 1978. Contract EY-76-C-04-3683. 491p. Dep. NTIS, PC A21/MF A01.

A number of problems that might occur if methanol were used as a blending stock or replacement for gasoline in present cars are identified and characterized as to the probability of their occurring and the severity of their consequences. Possibilities for correcting several problems are reported. Some problems are responsive to fuel modification but others require or are better dealt with by modification of vehicles and the bulk fuel distribution system. Phase separation on exposure to water and increased tendency to vapor lock, two major problems with blends, can both be alleviated by incorporation of cosolvent higher alcohols, ones which can be produced with methanol when it is manufactured from synthesis gas. Fuels consisting mostly of methanol require some modification of gasoline engines if the engines are to operate. If such modifications were made, starting cars at low temperatures would still be a problem. Startability can be provided by adding gasoline or light hydrocarbons; these increase the susceptibility of the fuel to vapor lock but not beyond tolerable limits. Addition of gasoline also alleviates other problems related to toxicity and safety hazards. Still other problems of both blends and methanol-rich fuels can be treated with selected additives. Some observations have been made on differences between methanol and ethanol in gasoline blends. An extension of the work is planned to study problems and corrective measures with ethanol-containing fuels.

978 (NP—23283) Report of the Automotive Energy Working Group. (Department of Energy, London (UK)). 17 Nov 1976. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Any forecasts of energy supply and demand over long periods have to be made in conditions of great uncertainty. However, the UK Department of Energy foresees that, after a period of net self-sufficiency in the 1980s and 1990s, an energy gap (in the sense that the United Kingdom would no longer be self-sufficient in energy) could emerge as the output of North Sea oil and gas moves into decline. There is no less uncertainty about world energy reserves and their duration. Ultimately recoverable oil reserves could last for more than 80 years at current rates of consumption, but for less than 40 years with 4% annual growth (lower than the historic growth rate between 1962 and 1973). A shortfall between supply and demand in the United Kingdom could develop towards the turn of the century, and investment strategies that have long lead times would clearly need to take account of the gap. There is little practical prospect of a major change in the type of fuel or in the power plants for road transport within the motor industry's investment cycle. Liquid fuel suitable for automotive use can be produced

from coal, but the price of oil relative to coal will have to increase substantially before such coal-derived fuels became competitive with oil-based automotive fuels. In principle, it would be possible to produce alcohol fuels by a number of routes using nuclear power in the form of process heat and electrolytic hydrogen. But these are very long term prospects and unlikely to contend with coal conversion. The direct use of hydrogen as an automotive fuel is also a possibility. On present evidence there is little practical prospect of road transport moving on a significant scale before the end of the century from the internal combustion engine or towards alternative fuels.

979 Octane number increase of military vehicles operating on unleaded gasoline. Tosh, J.D.; Gray, J.T.; Trescott, E.B. (Southwest Res Inst, US Army Fuels and Lubr Res Lab, San Antonio, Tex). *SAE Prepr.;* No. 750937, 1-10(1975).

The suitability of using unleaded gasoline in military and commercially designed equipment located at four Army installations has been evaluated over a two-year period. A total of 3007 vehicles were monitored during the evaluation for maintenance and performance problems. This paper presents informaton on vehicle octane number requirements and octane number increase trends measured on a selected group of vehicles during the evaluation period. Details of the fuels used, vehicles tested, test procedure and results are discussed.

980 Toxicologic evaluations of fuel additive--methylcyclopentadienyl manganese tricarbonyl (MMT). Moore, W.; Stara, J.F.; Hysell, D.; Malanchuk, M.; Burkart, J.; Hinners, R. (US EPA, Natl Environ Res Cent). *SAE Prepr.;* No. 750927, 1-9(1975).

This paper presents data, from laboratory animals, on the toxicity and metabolic fate of the fuel additive methylcyclopentadienyl manganese tricarbonyl (MMT) and the biological effects following exposure to automotive exhaust emissions generated from an engine system which was run on a fuel containing MMT. In most cases of human intoxication from Mn, the major route of exposure has been inhalation. Industrial exposures to high levels of various Mn compounds has been associated with two different clinical disease syndromes--manganic pneumonia and chronic manganese poisoning affecting the central nervous system. The most important factor that should be considered in determining the environmental impact of MMT is whether its usage will cause a significant increase in the ambient levels of Mn in highly populated areas with high traffic density.

MATERIALS

981 Diffusion of F^- ions in CaF_2 . Jacucci, G.; Rahman, A. (Department of Physics, University of Trento, Trento, Italy). *J. Chem. Phys.;* **69**: No. 9, 4117-4125(1 Nov 1978).

It is shown that in a recently reported model of the dynamics of CaF_2, the decay with time of the Fourier transform, $<\exp(ikxu(t))>$, of u(t), the F^- displacement, for various wave vectors k can only arise from diffusive motion occurring between the simple cubic anion sites of the fluorite structure. Most of the jumps (~80%) occur between near neighbor sites (i.e., they are in the 100 direction). The motion of F^- ions can be understood in terms of a spontaneous creation of anti-Frenkel pairs which diffuse and eventually get annihilated. At the temperature of this calculation (1590 K) the average number of such pairs at any instant is found to be 7.9 in an assembly of 216 anions. A detailed breakdown of the nature of various types of atomic jumps arising out of the dynamics of these pairs is also presented.

982 Sensitivity limitations for CW stimulated raman spectroscopy. Owyoung, A. (Sandia Labs., Albuquerque, NM). *Opt. Commun.;* **22**: No. 3, 323-328(Sep 1977).

It is demonstrated that cw stimulated Raman spectroscopy using low-power pump and probe sources is a viable coherent Raman technique for obtaining Raman spectra. A multipass Raman cell configuration is shown to be effective in providing enhancement of the output gain signal and the study of representative Raman modes in mixtures of several common solvents gives an experimental basis for assessing the ultimate sensitivity of the technique both for studies in dense media and high resolution applications in gaseous media.

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 21, 51, 575, 1160

983 (FE—6010-14) **Materials research for clean utilization of coal. Quarterly progress report, October—December 1977.** Schneider, S.J. (National Bureau of Standards, Washington, DC (USA). Inst. for Materials Research). [nd]. Contract EA-77-A-01-6010-002. 47p. Dep. NTIS, PC A03/MF A01.

The testing of specimens of 310 SS, 310s SS, 347 SS, 446 SS, Incoloy 800, and Inconel 671 was completed in a reducing coal gasification environment at temperatures of 450 and 600°C at a strain rate of $1 \times 10^{-6} s^{-1}$. The reducing environment did not seem to have a significant effect on the mechanical properties of any of the alloy specimens tested at 450°C when compared to the mechanical property values of the alloy specimens tested in the helium environment at 450°C. The reducing environment at 600°C did have a significant effect on 310s SS and Incoloy 800 by reducing the values of the mechanical properties when compared to the data for the same alloys tested at 600°C in the helium environment. The effect of the reducing environment at 600°C on the other alloys did not seem to be significant. A low-alumina refractory concrete has been exposed to a 70 percent H_2O—30 percent CO_2 environment at temperatures of 510, 710, 910°C and at pressures of 7.5 and 15.0 MPa. The room temperature flexural strength, compressive strength and erosion resistance of the concrete all increased after exposure. Construction of the high pressure-temperature viscosity apparatus has been completed and a synthetic slag has been melted in steam proving the adequacy of the heating system under pressure conditions. The Failure Prevention Information Center continued to enlarge its data collection activity. The establishment of the work and procedures of the Center continued with the formation of the library of contractors' reports, study of the formatting needs for a suitable computer system, investigation of computer data management systems, study of two series of contract reports, and preparation and revision of summary reports.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 33, 1020, 1093

984 (BDX—613-1873(Rev.)) **Deposition and characterization of vacuum deposited aluminum films on Kapton laminates.** Sherman, D.M. (Bendix Corp., Kansas City, MO (USA)). Jul 1978. Contract EY-76-C-04-0613. 29p. Dep. NTIS, PC A03/MF A01.

A process has been developed for the vacuum deposition by electron beam evaporation of high quality aluminum films 10 μm thick on domed three-layer laminated substrates consisting of Kapton/Pyralux/Kapton/Pyralux/Aluminum (Du Pont Corporation). Thermogravimetric analysis and mass spectrometry of the substrate materials and in-process residual gas analysis were used to determine the outgassing characteristics of the substrate laminate and to aid in the development of suitable thermal processing. The laminated substrates required bakeouts both at atmosphere and in high vacuum prior to deposition to permit evaporation at a pressure of 0.1 mPa (1×10^{-6} torr). Film properties that were obtained were a thickness uniformity across a 200 mm diameter part in the 1 percent range, a resistivity near that of bulk pure aluminum, a smooth and shiny film surface, and adequate film adhesion.

985 (CONF-780650—6) **Ultrasonic characterization of austenitic welds.** Adler, L.; Cook, K.V.; Fitting, D.W. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

From 1. symposium on ultrasonic materials characterization; Gaithersburg, MD, USA (7 Jun 1978).

Nondestructive evaluation of austenitic stainles steel weld metal is a very difficult problem. Mechanical anisotropy appears to be a major contribution and is caused by preferred local orientation of elongated subgrains and preferred crystallographic orientation. The result of this anisotropy is the directional dependence of the ultrasonic velocities (shear and longitudinal) and ultrasonic attenuation. The directional dependence of these ultrasonic parameters causes large errors in locating and sizing flaws in welds. Initial studies were carried out in a type 308 stainless steel electroslag weld to characterize this anisotropy. The apparent symmetry in the macrostructure of the electroslag weld leads us to expect orthotropic symmetry in elastic constants. A technique was developed to measure variations in velocity and attenuation with direction. The velocity data compared favorably to theoretical calculations using this orthotropic model. From the velocity data all elastic constants and engineering constants for this weld were determined. Studies of other types of welds showed that orthotropic symmetry is typical of austenitic welds. Data will be presented to show how anisotropy affects defect location and sizing in welds.

986 (LBL—7656) **Development of high temperature scanning electron microscopy and applications to sintering studies.** Wang, D.N.K.; Miller, D.J.; Fulrath, R.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1978. Contract W-7405-ENG-48. 23p. (CONF-780415—4). Dep. NTIS, PC A02/MF A01.

From Scanning electron microscopy conference; Los Angeles, CA, USA (16 Apr 1978).

The densification and microstructural changes of a metallic and/or ceramic powder compact during sintering is a critically important but incompletely understood process. Whether solely in the solid state or in the presence of a liquid phase, mass transport occurs at elevated temperatures to eliminate porosity and reduce the surface energy of the system. Changes in specimen dimensions, particle shape and pore morphology, formation of liquid phases and other direct evidence of the sintering process have been observed and recorded at temperature using video tape and 16mm time lapse movies of the TV scanning image. Materials that have been examined at elevated temperature are Ni, glass, Al_2O_3, UO_2, W, Cu, WC-Co, and CaF_2.

987 (MLM—2526) **Migration of iron, nickel, cobalt and chromium associated with silver brazing during ceramic-to-metal joining.** Etter, D.E.; Egleston, E.E.; Jaeger, R.R. (Monsanto Research Corp., Miamisburg, OH (USA)). 30 Jun 1978. Contract EY-76-C-04-0053. 10p. Dep. NTIS, PC A02/MF A01.

During the study of bond strengths of ceramic-to-metal seals under various brazing conditions, it was observed that the strength was affected by the length of time that the braze material was in the liquid state. Brazing times as short as 10 min sometimes adversely affected the strength of the seal. Photomicrographs of a typical weak bond clearly show silver braze penetration deep in the metallizing layer after 10 min at 20°C above the melting point of the braze. A reaction layer was also observed in the photomicrographs. Considerable iron has migrated from the Kovar pin through the silver braze and formed an interface between the silver braze and the molybdenum metallizing material. Significant concentrations of cobalt and nickel were also found in the reaction zone, indicating a diffusion reaction of Kovar through the silver. Further investigations showed that while braze durations as short as 1 min at 20°C above the liquid temperature gave much stronger bonds than 10 min did, significant migration of material was evident. In view of the significant migration of both the pin alloy and the braze material, it was concluded that brazing time and temperature should be minimized to achieve maximum bond strength.

988 (RFP—2800) **Weld pool motion in GTA welding: importance and description.** Mills, G.S. (Atomics International Div., Golden, CO (USA). Rocky Flats Plant). 1978. Contract EY-76-C-04-3533. 16p. (CONF-780834—1). Dep. NTIS, MF A01.

From 5. Bolton Landing conference; Lake George, NY, USA (27 Aug 1978).

Portions of document are illegible.

Studies of material and arc effects on penetration in GTA welding are summarized and the resulting conclusions given. Metal flow in the weld pool, the apparent control mechanism, is described as having two basically different patterns which lead to the observed fusion zone shapes. Experimental evidence for these patterns and their likely mode of interaction with the arc are also presented.

989 (Y—2126) **Factors affecting the deformation of tungsten (a literature survey).** Ludwig, R.L. (Oak Ridge Y-12 Plant, TN (USA)). 25 Aug 1978. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

Background information relative to wrought tungsten forming was required in support of development studies. Seven principal areas of tungsten metallurgy were of interest: fabrication methods, delamination, recrystallization, heat treatment, fracture characteristics, impurity effects, and surface treatments. Pertinent information in Metal Abstracts from 1967 to mid 1977 was summarized for each area. Only a few papers were reviewed in their entirety; the great majority of information was derived from abstracts of the papers. 61 references.

990 (Y—2128) **High-strength uranium-0.8 weight percent titanium alloy penetrators.** Northcutt, W.G. (Oak Ridge Y-12 Plant, TN (USA)). Sep 1978. Contract W-7405-ENG-26. 20p. Dep. NTIS, PC A02/MF A01.

Long-rod kinetic-energy penetrators, produced from a uranium-0.8 titanium (U-0.8 Ti) alloy, are normally water quenched from the gamma phase (approximately 800°C) and aged to the desired hardness and strength levels. High cooling rates from 800°C in U-0.8 Ti alloy cylindrical bodies larger than about 13 mm in diameter cause internal voids, while slower rates of cooling can produce material that is unresponsive to aging. For the present study, elimination of quenching voids was of paramount importance; therefore, a process including the quenching of plate was explored. Vacuum-induction-cast ingots were forged and rolled into plate and cut into blanks from which the penetrators were obtained. Quenched U-0.8 Ti alloy blanks were aged at 350 to 500°C to determine the treatment that would provide maximum tensile and impact strengths. Both tensile and impact strengths were maximized by aging in vacuum for six hours at 450°C.

991 **Thermomechanical processing.** Zackay, V.F. (Univ. of California, Berkeley). *Mater. Sci. Eng.;* **25**: 247-261(1976).

In the ensuing discussion, the emphasis will be centered on a description of the effectiveness of this integrated analytical approach that has been used so successfully in the past several years--an approach that has culminated in the large scale production of HSLA (high strength low alloy) steels and one which promises to have similar technological success with respect to superalloys and, possibly, to aluminum and titanium alloys. Throughout this discussion, an attempt will be made to underscore what is not known and what additional knowledge and understanding are needed for continued progress.

992 **Characterization and mechanism of repeated precipitation on dislocations in an Al—Cu alloy.** Headley, T.J.; Hren, J.J. (Univ. of Florida, Gainesville). *Philos. Mag.;* **34**: No. 1, 101-117(1976).

The process of repeated precipitation on dislocations in Al-3.85 wt percent Cu has been examined by transmission electron microscopy. The theta' phase is found to precipitate repeatedly on climbing dislocations during quenching from the solid-solution range directly to the ageing temperature, occurring on both dislocation-climb sources and glide dislocations which climb off their slip planes. The resultant colonies of stable theta' precipitates are unresolved immediately after quenching but become visible upon sufficient ageing. The mechanism for repeated precipitation of theta' in Al-Cu differs from mechanisms proposed for other alloy systems since it does not require a cooperative vacancy flux between growing precipitates and climbing dislocatons. Rather, the dislocations climb by annihilation of quenched-in vacancies, while theta' precipitates simultaneously by simple heterogeneous nucleation in the stress fields of the moving dislocations. Methods for enhancing the local solute concentration for repeated nucleation are considered, and a model is proposed which accounts for the spatial distribution and orientations of precipitates in the colonies.

993 **Heat treatment of cast tungsten alloys.** Savitskii, E.M.; Povarova, K.B.; Shegai, A.A.; Postnov, L.M.; Makarov, P.V.; Popov, A.P. *Met. Sci. Heat Treat. (USSR) (Eng. Transl.);* **17**: No. 3-4, 291-294(Sep 1975).

The characteristic effects of heat treatment on the structure of cast tungsten alloys of the W-C-M (Zr, Nb, Ta, Re, OS) system are examined for three groups: tungsten-base solid solutions, alloys containing secondary carbides (W2C or MC) together with the solid solution, and alloys containing eutectics. Optimal structure of cast tungsten-base alloys containing a carbide phase can be obtained by alloying in such a manner that the composition within a given temperature range corresponds to regions W + MC or W2C + MC on ternary or more complex phase diagrams. It is preferable if the alloying elements permit electro slag remelting with subsequent rapid cooling. High-temperature (above 2500°C) heat treatment followed by deformation at lower temperatures is recommended for alloys produced by vacuum arc remelting or electron beam remelting.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 685, 694, 986, 1015, 1059, 1062, 1064, 1065, 1081, 1091, 1657

994 (CONF-780213—13) **Stable phases in aged type 321 stainless steel.** Bentley, J.; Leitnaker, J.M. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A02/MF A01.

From 107. AIME meeting; Denver, CO, USA (26 Feb 1978).

X-ray diffraction and Analytical Electron Microscopy have been used to characterize the precipitate phases present in type 321 stainless steel after 17 years of service at approximately 600°C. The morphology, crystallography, and orientation relationships with the matrix of the precipitates have been determined along with the chemical composition of several of the phases. Long-term aging of type 321 stainless steel indicates TiC, not $M_{23}C_6$, is the stable carbide phase. A theory is developed to explain appearance of $M_{23}C_6$ at intermediate times. The theory also indicates the means for preventing $M_{23}C_6$ formation and hence sensitization of the steel to intergranular corrosion. The amount of sigma found correlates well with results from shorter time studies. $Ti_4C_2S_2$ and a complex phosphide-arsenide were also present.

995 (CONF-780818—7) **Image contrast of dislocating loops in anisotropic cubic crystals.** Ohr, S.M. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 3p. Dep. NTIS, PC A02/MF A01.

From Electron microscopy conference; Toronto, Canada (1 Aug 1978).

A computer program to generate simulated electron micrographs has been used to calculate the image contrast of dislocation loops in cubic crystals by taking into account the effect of elastic

anisotropy. The displacement field was numerically calculated for a circular dislocation loop of finite size from the Fourier transform of the elastic Green's function. The image contrast was calculated under two-beam dynamical diffraction conditions using the Howie-Whelan equations. In an isotropic medium, the black-white contrast direction of a Frank loop imaged under the exact (002) Bragg reflection makes an angle of approximately 15° from the direction of Burgers vector. In copper and nickel, the anisotropic calculations show that the black-white contrast is parallel to and is elongated considerably along the direction of the Burgers vector. In niobium, the black-white contrast direction of a perfect loop of a/2[111] type lies about halfway between the directions of the Burgers vector and the diffraction vector. It is concluded that the image contrast of dislocation loops in cubic crystals is highly sensitive to the elastic anisotropy and hence it is necessary to take the effect of anisotropy into account in order to perform an accurate analysis of the loop image.

996 (IS-T—827) **Lattice dynamics of γ—Ce.** Gould, T.A. (Ames Lab., IA (USA)). Aug 1978. Contract W-7405-ENG-82. 166p. Dep. NTIS, PC A08/MF A01.

Thesis.

The phonon and magnetic measurements described in the thesis produced the following significant results concerning the lattice dynamical and magnetic properties of γ-Ce. The phonon spectrum is relatively soft, which is consistent with results obtained for $CeSn_3$. The L [110] and T [111] branches of the dispersion curve are anomalous. The C_{11} and C_{44} elastic constants are quite close in value. No discrete magnetic excitations were observed. The magnetic scattering is qualitatively similar to the results from $Ce_{0.74}Th_{0.26}$, however, GAMMA/sub Ce/ less than GAMMA/sub Ce-Th/. The various lattice dynamical and magnetic similarities among γ-Ce, $CeSn_3$, and $Ce_{0.74}Th_{0.26}$ are mixed valence compounds. Therefore, a complete theoretical description of the observed properties of Ce and its compounds may provide a basis for understanding a whole class of mixed valence materials. (GHT)

997 (LA-UR—78-1762) **Applicability of a valence fluctuation model to the observed physical property response of actinide materials.** Sandenaw, T.A. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 6p. (CONF-780823—2). Dep. NTIS, PC A02/MF A01.

From Conference on the electronic structure of the actinides; Grenoble, France (30 Aug 1978).

It is shown that the physical property behavior of the light actinide elements, U, Np, and Pu, and certain of their alloys, is like that of known mixed-valence, R.E. metallic compounds. It is inferred that interconfiguration fluctuation (ICF) theory should also be applicable to actinide materials.

998 (LBL—7671) **Moessbauer study of austenite stability and impact fracture in Fe--6Ni steel.** Fultz, B.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1978. Contract W-7405-ENG-48. 65p. Dep. NTIS, PC A04/MF A01.

Thesis.

The two phase (α + γ) microstructure of a commercial cryogenic alloy steel was studied with regard to possible phase transformations induced by impact fracture. A backscatter Moessbauer spectrometer was constructed for measurements of atomic fractions of the two phases near specimen surfaces. Moessbauer spectra were collected from several types of unpolished and chemically polished surfaces of impact specimens to reveal (for the first time) the depth profile of the observed $\gamma \rightarrow \alpha'$ transformation near fracture surfaces. It was found that the spatial extent of transformation could be monotonically related to the impact energy absorbed by the specimen. These results are interpreted in light of several models of phase stability and impact toughness. A general description of the Moessbauer effect and methods of spectral analysis is included. The method of linear perturbations in the hyperfine magnetic field is discussed with respect to its general usefulness in obtaining chemical information for Moessbauer spectra of the α phase. The procedure adopted for spectral analysis was chosen to provide an accurate phase analysis at the expense of chemical information. Both the Moessbauer equipment and analysis procedures were developed with the primary objective of providing a routine metallurgical phase analysis technique for low alloy steels.

999 (LBL—7677) **Advances in characterization of materials: alloys and ceramics.** Thomas, G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1978. Contract W-7405-ENG-48. 14p. (CONF-780818—9). Dep. NTIS, PC A02/MF A01.

From Electron microscopy conference; Toronto, Canada (1 Aug 1978).

The advantages of high resolution electron diffraction and imaging have been revealed in a wide variety of metallic systems, providing insight into the mechanisms of such phase transformations as ordering, spinodal decomposition, grain boundary precipitation, and the martensitic reaction. Structural discontinuities in interphase interfaces (atomic plane ledges) and grain boundaries (plane matching defects) have been identified with high precision, and compositional variations on an atomic scale have been detected, including solute segregation within approximately 10 A of a grain boundary. In the study of ceramics, primary effort has been directed toward the detection of thin intergranular films with notable success. Atomic dimension microledges have also been revealed in crystallization interfaces, polytype boundaries and transformation fronts, and compositional variations near grain boundaries have recently been recorded in lattice images of a Magnesium Sialon. It therefore appears that the technique holds equal promise for analysis of the fundamental mechanisms of crystallization, phase transformation, diffusion and solute segregation in ceramics as well as metallic alloy systems. The work presented here represents some of the potential of high resolution methods and is an initial step towards complete atomic characterization of materials. The most desirable progression of such research should lead to the attainment of structural images similar to those that are currently being used to explore the atomic arrangements in mineralogical specimens. This requires only a slight improvement in the contrast transfer characteristics of present day electron optics.

1000 (LBL—7681) **Plastic deformation of crystals: analytical and computer simulation studies of dislocation glide.** Altintas, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1978. Contract W-7405-ENG-48. 151p. Dep. NTIS, PC A08/MF A01.

Thesis.

The plastic deformation of crystals is usually accomplished through the motion of dislocations. The glide of a dislocation is impelled by the applied stress and opposed by microstructural defects such as point defects, voids, precipitates and other dislocations. The planar glide of a dislocation through randomly distributed obstacles is considered. The objective of the present research work is to calculate the critical resolved shear stress (CRSS) for athermal glide and the velocity of the dislocation at finite temperature as a function of the applied stress and the nature and strength of the obstacles. Dislocation glide through mixtures of obstacles has been studied analytically and by computer simulation. Arrays containing two kinds of obstacles as well as square distribution of obstacle strengths are considered. The critical resolved shear stress for an array containing obstacles with a given distribution of strengths is calculated using the sum of the quadratic mean of the stresses for the individual obstacles and is found to be in good agreement with the computer simulation data. Computer simulation of dislocation glide through randomly distributed obstacles containing up to 10^6 obstacles show that the CRSS decreases as the size of the array increases and approaches a limiting value. Histograms of forces and of segment lengths are obtained and compared with theoretical predictions. Effects of array shape and boundary conditions on the dislocation glide are also studied. Analytical and computer simulation results are compared with experimental results obtained on precipitation-, irradiation-, forest-, and impurity cluster-hardening systems and are found to be in good agreement.

1001 (LBL—8013) **On the orientation relationships between retained austenite and "lath" martensite.** Rao, B.V.N. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1978. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

Some observations made on the orientation relationships of the austenite → lath martensite transformation are reported.

1002 (SAND—78-0797) **Volume dependence of the electronic structure of Cu_2Mg.** Schirber, J.E.; Switendick, A.C.; Gordon, W.L. (Sandia Labs., Albuquerque, NM (USA); Case Western Reserve Univ., Cleveland, OH (USA)). 1978. Contract EY-76-C-04-0789. 5p. (CONF-780824—7). Dep. NTIS, PC A02/MF A01.

From 15. conference on low temperature physics; Grenoble, France (23 Aug 1978).

Measurements were made of the pressure dependence of several cross sections of the Fermi surface of Cu_2Mg and compare them with a volume dependent band structure calculation.

1003 **Maximum superconducting transition temperatures in A15 compounds.** Ho, K.M.; Cohen, M.L.; Pickett, W.E. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **41**: No. 12, 815-818(18 Sep 1978).

Strong electron-phonon scattering results in a smearing of the peak structure in the electronic density of states in high-T/sub c/ A15 materials. This smearing may impose limits on the highest T/sub c/ achievable for these and similar materials. Numerical estimates are made using band structure and electrical resistivity data.

1004 **Ionic model for Cr, Mn, and Fe impurities in Cu.** Abbas, D.C.; Aton, T.J.; Slichter, C.P. (Materials Research Laboratory and Department of Physics, University of Illinois at Urbana—Champaign, Urbana, Illinois 61801). *Phys. Rev. Lett.;* **41**: No. 10, 719-722(4 Sep 1978).

We report studies of the temperature dependence of the Knights shift of Cu atoms near to Cr atoms in dilute CuCr alloys. Comparison with CuMn and CuFe leads us to propose electronic structures for these important systems. We confirm the general picture of Hirst: The atoms have integral numbers of 3d electrons and obey Russell-Sanders coupling, but the sign of the crystal field is opposite to that of Hirst, and Fe has seven rather than six 3d electrons.

1005 Low-temperature specific heats of glassy Pd/sub 1-x/-ySi/sub x/Cu/sub y/ alloys. Mizutani, U.; Hartwig, K.T.; Massalski, T.B.; Hopper, R.W. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev. Lett.;* **41**: No. 9, 661-664(28 Aug 1978).

Measurements are reported of low-temperature specific heats in a number of binary and ternary amorphous Pd-Si and Pd-Si-Cu alloys. The results indicate that the linear-term temperature coefficient, γ, changes with electron concentration and shows a pronounced maximum near e/a = 1.6. The glassy alloys are also characterized by a large T^5-term coefficient and a relatively low limiting Debye temperature. The hypothesis of a minimum in the density of states at the Fermi level within glassy range has not been confirmed.

1006 Metallic bonding and the character of electronic states in Nb_3Ge and Nb_3Al. Ho, K.M.; Pickett, W.E.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **41**: No. 8, 580-582(21 Aug 1978).

The electronic charge density for Nb_3Ge and Nb_3Al is calculated using a self-consistent pseudopotential technique. Results indicate that there is charge transferred from Nb and Ge to the interstitial region, suggesting a metallic bonding description of these compounds. The charge transfer from Ge to Nb is not prominent as suggested by the Bongi model. Calculated charge densities for states near the Fermi level suggest that R and M are more sensitive to atomic displacements along the chain than the points Γ and X chosen previously to explain A-15 Martensitic transitions.

1007 Morphology and crystallography of directionally solidified Pb—Sn eutectic alloys. Verhoeven, J.D. (Iowa State Univ., Ames); Mourer, D.P.; Gibson, E.D. *Metall. Trans., A;* **8**: 1239-1247(Aug 1977).

Directional solidification of Pb-Sn eutectic alloys at high temperature gradients has shown that two distinct eutectic morphologies occur, a regular lamellar structure and a wavy lamellar structure, termed degenerate. An electron channelling technique was used to characterize the crystallography of the two morphologies. The degenerate grains grow in advance of the regular grains and are the preferred growth morphologies in spite of the fact that coarsening experiments revealed that the degenerate grains possessed a higher lamellar interface energy. This result conflicts with the Zener model of eutectic growth. A possible rationalization of this conflict based on the anisotropy of thermal conductivity in Sn is presented.

1008 Calculation of the surface density of electronic states in lead. McFeely, F.R.; Falicov, L.M. (Lawrence Berkeley Lab., CA). *Solid State Commun.;* **21**: 343-346(1977).

A tight-binding calculation of the local surface density of states for the (001) surface of lead is presented. It is based on a simple phenomenological interpolation scheme which replaces the one-dimensional bulk density of states normal to the surface by a surface adapted curve. The integration over the two-dimensional Brillouin zone is performed numerically. The calculation explains qualitatively differences observed between experimental x-ray photoemission density of states and bulk-value calculations in both s-like and p-like bands.

1009 Simulations of shock waves in solids. Paskin, A. (Univ. of New York, Flushing); Gohar, A.; Dienes, G.J. *J. Phys., C (London);* **10**: 1-4(1977).

Shock wave simulations have been carried out to 800 planes for BCC iron using a Morse potential. Analysis showed that the Hugoniot conservation relations are obeyed even for non-constant shock profiles if appropriate averages over the complete shock region are used. Various definitions of temperature for the shocked region were examined. The anomalies reported by Tsai and MacDonald were not observed.

1010 Surface composition of binary metal alloys. The regular soluion theory. Jablonski, A. (Univ. of California, Berkeley). *Adv. Colloid Interface Sci.;* **8**: 213-236(1977).

A theory predicting the surface composition of binary metal alloys on the basis of thermodynamic data is presented. The equation describing the surface composition is derived for the random solution model and the short range order model. The surface compositions calculated for both models are found not to differ significantly. The experimentally determined surface compositions of binary metal alloys by means of the Auger electron spectroscopy are reviewed and compared with the theory. The theory is found to predict the direction of surface enrichment, but the extent of surface segregation is overestimated in most of the cases.

1011 Formation of multilayer (α') and defect martensite phases in cobalt—titanium alloys. Nikolin, B.I. (Inst. of Metal Physics, Kiev). *Dokl. Akad. Nauk SSSR;* **233**: No. 4, vp(1977). (In Russian).

X-ray studies of Co-Ti, Co-Ni, Co-Mn, Co-W and Co-Mo single crystals were undertaken in order to determine the possibility of appearance of multilayer martensite phases in them. Attempts were made to detect multilayer and defect martensite phases in Co-Ni, Co-Mn, Co-Mo and Co-W alloys. It was found that in these systems after hardening and repeated (β reversible $\rightarrow \alpha$) transition (up to 500 cycles), a hexagonal close packed lattice of α-martensite is formed with low chaotic packing defect density (less than 0.10), but neither multilayer nor defect structures arise. Analysis of the results produced indicates that multilayer and defect structures arise in binary cobalt alloys in which: (1) the solubility of the alloying element is low; and (2) the martensite conversions occur at below-freezing temperatures.

1012 Computer simulation of the contrast of small dislocation loops in field-ion images of f.c.c. crystals. Stolt, K.; Washburn, J. (Lawrence Berkeley Lab., CA). *Philos. Mag.;* **34**: No. 6, 1169-1184(1976).

It is shown that small dislocation loops of diameter 30 A or less cause field-ion image contrast while wholly inside the tip. During a field-evaporation sequence that brings the loop successively closer to the surface, characteristic changes in the contrast occur which make it possible to distinguish between vacancy-type and interstitial-type loops. For a single photograph, however, unambiguous interpretation of the image contrast observed is not possible for small loops. The contrast effects for small loops are in many cases rather slight distortions of the image rings and, for a single photograph, could occur for other reasons such as tip asymmetry or the presence of impurities. For this reason an entire field-evaporation sequence is essential. It is pointed out that only sessile loops can be observed in the FIM, since the stresses associated with the electric field will remove glissile loops from the specimen.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 618, 635, 643, 685, 989, 1076, 1080

1013 (COO—3084-61) Combined macroscopic and microscopic approach to the fracture of metals. Technical progress report, July 1977—June 1978. Gurland, J.; Rice, J.R.; Asaro, R.J.; Needleman, A. (Brown Univ., Providence, RI (USA). Div. of Engineering). Jun 1978. Contract EY-76-S-02-3084. 23p. Dep. NTIS, PC A02/MF A01.

The work reported includes studies on: (1) The role of particles and interfaces in the initiation of fracture, including fundamentals of brittle versus ductile response of interfaces and observations on cavity growth by the cracking of grain or sub-grain boundaries adjacent to carbides in spheroidized steels; (2) Environment sensitive fracture mechanisms, particularly the effect of hydrogen in reducing tensile ductility by acceleration of the crack-like mode of cavity growth along grain boundaries in steels; (3) Models for elevated temperature diffusive processes of cavity growth on grain interfaces, including non-equilibrium effects and crack-like growth modes; (4) Localization of plastic deformation and the inception of ductile rupture; and (5) Elastic-plastic stress analysis, by finite elements, of growing cracks and examination of criteria for stable crack growth.

1014 (COO—4246-5) Microstructural effects in abrasive wear. Quarterly progress report, 15 March 1978—15 June 1978. Fiore, N.F.; Coyle, J.P.; Udvardy, S. (Notre Dame Univ., IN (USA). Dept. of Metallurgical Engineering and Materials Science). 1 Jul 1978. Contract EF-77-S-02-4246. 25p. Dep. NTIS, PC A02/MF A01.

The objective of this research is to correlate abrasive wear with microstructure in a series of alloy white irons and a series of Co-base powder metallurgy (PM) alloys. Low-stress abrasion resistance has been found to increase in a general way with hardness, whereas gouging wear resistance has been found to correlate to a significantly lesser extent. For gouging wear in particular, increasing hardness, carbon and alloy content are inefficient means to increase wear resistance. The low-stress wear scar microtopography has been measured for each of the six alloys studied. In general, alloys with high wear resistance have smoother wear scars. The microstructures of the alloys, which consist of an array of M_7C_3 (and in some cases M_7C_3 + M_6C) carbides in a FCC Co-base matrix, have been characterized by conventional optical and quantitative metallographic techniques. Both low stress and gouging wear resistance pass through a maximum at intermediate carbide volume fractions. This gives quantitative evidence of the inefficiency of excessive alloying to generate wear resistance. It suggests that for these alloys low-

stress and gouging abrasion may be covered by common flow-fracture phenomena.

1015 (HEDL-SA—1332) **Limiting recrystallization in austenitic stainless steels for structural applications.** Moen, R.A.; Farwick, D.G. (Hanford Engineering Development Lab., Richland, WA (USA)). 1978. Contract EY-76-C-14-2170. 15p. (CONF-780609—17). Dep. NTIS, PC A02/MF A01.

From ASME/CSME pressure vessels and piping conference; Montreal, Canada (25 Jun 1978).

Recovery and recrystallization of cold-worked austenitic stainless steels may result in properties lower than the published values for annealed materials. One method to enable the use of cold-worked austenitic stainless steel in elevated temperature construction is to preclude conditions of cold work, time, and temperature that lead to recovery and recrystallization. The objective in setting such limits is to ensure that the strength properties remain above those on which allowable stresses are based. The scope of this paper is limited to those austenitic stainless steels now used for Class 1 elevated temperature nuclear construction, with additional consideration given to typical service times and temperatures. This paper attempts to define such limits using stress-rupture test results.

1016 (LBL—7328) **Investigation of two-body abrasive wear.** Hirano, H.H.; Levy, A.V. (Sandia Labs., Livermore, CA (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1978. Contract W-7405-ENG-48. 50p. (CONF-780666—2). Dep. NTIS, PC A03/MF A01.

From Conference on fundamentals of tribology; Cambridge, MA, USA (19 Jun 1978).

An investigation of two-body abrasive wear utilizing a pin specimen on a rotating SiC particle abrasive paper test device is described. The test materials were 7075 aluminum and 4340 steel which were thermally treated to attain a range of hardness, fracture toughness and yield strength values. Wear resistance is seen to correlate directly with hardness and yield strength for both materials. For the 4340 steel the wear resistance is inversely proportional to the fracture toughness; for the 7075 aluminum, the inverse proportionality is dependent upon the microstructure. The effect of an increase in hardness by heat treatment of an alloy is much less pronounced than when the wear resistance of pure metals of differing hardness is compared. Scanning electron microscopy of abraded surfaces was used to examine the removal mechanisms involved in abrasive wear. The meaning of the observed mechanisms in terms of a model are assessed.

1017 (NBSIR—78-884) **Materials studies for magnetic fusion energy applications at low temperatures. I.** Fickett, F.R.; Reed, R.P. (eds.). (National Bureau of Standards, Boulder, CO (USA). Thermophysical Properties Div.). Apr 1978. Contract EA-77-A-01-6010-024. 363p. Dep. NTIS, PC A16/MF A01.

The reports presented here summarize the work of the low temperature materials research project for the first year of the program. The various projects are outlined and the research results are presented. The major thrust of the measurements has been the evaluation of the low temperature properties of stainless steel base metal and welds, with particular emphasis on the nitrogen strengthened stainless steels. Some initial work has also been done on the production and properties of nonmetallics, primarily industrial laminates, for low temperature applications. A handbook of material properties is also planned. A survey of low temperature materials needs and problems related to magnetic fusion energy, performed by NBS as groundwork for the program, is included as is a brief description of the first workshop held in October 1977.

1018 (NUREG/CR—0057) **Critical experiments, measurements, and analyses to establish a crack arrest methodology for nuclear pressure vessel steels. Third annual progress report, October 1976—September 1977.** Hahn, G.T.; Corten, H.T.; Debel, C.P. (Battelle Columbus Labs., OH (USA)). May 1978. 227p. (BMI—1995). NTIS $9.50.

Results of a program aimed at dynamic analyses of crack arrest in test pieces and thermally shocked nuclear pressure vessels, a practical laboratory test method for measuring the crack arrest toughness, and a crack arrest data base for nuclear steels and weldments are described. Dynamic, two-dimensional finite difference analyses of run-arrest events in single-edge notch and compact tension specimens have been carried out and refined. Verification of the two-dimensional analysis has been obtained by comparing its predictions with detailed experiments which were performed independently. In addition, the governing equations have been derived for a dynamic, two-dimensional analysis of a long axial crack propagating radially in the wall of a cylinder under thermal shock. A preliminary trial of the analysis has been conducted for the conditions of the ORNL Thermal Shock Experiments. Finally, this report describes work on a new method for calculating the interaction of a propagating and arresting crack with an incident dilatational wave. A test method for measuring the crack arrest toughness values of practical interest has been developed, refined, verified and submitted to the ASTM for standardization. The method requires relatively simple, static measurements, and involves longitudinal or transverse wedge loading, the double cantilever beam or compact specimen geometry, and ordinary r duplex test pieces. A cooperative test program to familiarize potential users with this method has been organized and will be carried out in 1978. The possibility of reducing the volume of irradiated test material through the use of electron-beam-welded compound specimens was studied. This work indicates that the technical problems can be overcome, but material savings currently do not warrant the cost of the development.

1019 (NUREG/CR—0085) **Evaluating strength and ductility of irradiated Zircaloy: Task 5. Quarterly progress report, January—March 1978.** Bauer, A.A.; Gallagher, W.J.; Lowry, L.M.; Markworth, A.J. (Battelle Columbus Labs., OH (USA)). Apr 1978. 54p. (BMI—2000). NTIS $5.25.

Bend tests have been conducted on cladding from H. B. Robinson and first-cycle Oconee spent-fuel rods. Stresses required to produce a maximum fiber strain of 0.02 percent and to produce a 10.8-cm (4-in.) radius of curvature have been measured as a function of temperature from 25 to 427 C. The cladding from the higher burnup H. B. Robinson rods exhibits slightly greater strength than the Oconee cladding. Calculation of bend modulus over the same temperature range indicate a maximum near 200 C. Revised strain calculations, based on the complete specimen circumference, have been made for the expanding-mandrel tests reported in BMI-1992. Previous strain calculations based on the gap between mandrel sections resulted in calculated strains ranging to over 300 percent. In the revised calculations strains are reduced by a factor of almost 10. The lower values are consistent with O.D. surface measurements obtained from scribed specimens that showed no evidence of large localized deformation. Tube-wall reductions accompanied by straightening of the tube O.D over the gap between mandrel sections and the formation of cracks at the tube I.D. appear to occur as a result of circumferential deformation that is concentrated at the tube. I.D. Isothermal tube-burst tests have been conducted and data showing the effect of test temperature, strain rate, and annealing are reported. Analysis of tensile-test annealing data has continued with the goal of developing a model to describe isothermal and transient annealing behavior of spent-fuel Zircaloy cladding. A modified method for treating isothermal annealing data was adopted in which, contrary to earlier assumptions, the total property change was assumed to be independent of temperature. A regression equation was developed that provided a relatively good fit to ductility changes recorded following isothermal annealing. Additional transient-heating tube-burst tests have been conducted on Oconee spent-fuel cladding.

1020 (ORNL/BRP/M—78/6) **Breeder reactor program: materials. Technical status report for June 1978.** Goodwin, G.M. (Oak Ridge National Lab., TN (USA)). Jun 1978. Contract W-7405-ENG-26. 21p. AT.

Breeder reactor materials are discussed. Data are presented concerning improved welds, steam generator materials, NDT, advanced breeder structural materials development, mechanical properties of structural materials for breeders, and fabrication of piping and pipe fittings. (FS)

1021 (ORNL/NUREG/TM—209) **Heavy-Section Steel Technology Program. Quarterly progress report, January—March 1978.** Whitman, G.D.; Bryan, R.H. (Oak Ridge National Lab., TN (USA)). 20 Jun 1978. Contract W-7405-ENG-26. 69p. (NUREG/CR—0106). Dep. NTIS, PC A04/MF A01.

The Heavy-Section Steel Technology (HSST) Program is an engineering research activity conducted by the Oak Ridge National Laboratory for the Nuclear Regulatory Commission. It comprises studies related to all areas of the technology of the materials fabricated into thick-section primary-coolant containment systems of light-water-cooled nuclear power reactors. The principal area of investigation is the behavior and structural integrity of steel pressure vessels containing cracklike flaws. Current work is organized into seven tasks: (1) program administration and procurement, (2) fracture mechanics analyses and investigations, (3) effect of high-temperature primary reactor water on subcritical crack growth of reactor vessel steels, (4) investigations of irradiated materials, (5) pressure vessel investigations, (6) thermal shock investigations, and (7) foreign research. Stress-intensity factors are being measured photoelastically for nozzle corner cracks out of the plane of the intersecting cylinder axes. The study of ramp- and hold-time effects in fatigue testing is continuing, and the influence of the environment on the apparent starting ΔK effect was investigated. Precracked Charpy specimens of irradiated weld metal with low ductile shelf toughness were tested in slow bending, and preparations for J-integral testing of larger specimens in this series are continuing. The machined portion of the flaw of vessel V-8 was completed and fatiguing of the notch was started. Further experimental studies of enhanced heat transfer for cryogenic thermal shock tests were made.

1022 (ORNL/TM—6269) **Long-term creep tests after 30,000 hr on reference heat (9T2796) of type 304 stainless steel: interim report.** Sikka, V.K. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 191p. AT.

Long-term creep testing of a 51-mm plate of type 304 stainless steel started in 1971. The following areas are covered: the status of creep tests after 30,000 hr; analysis of minimum creep rate (epsilon/sub m/) and time to rupture (t/sub r/) data; relationship between tensile and creep properties; the comparison of long-term creep data with the currently accepted Blackburn creep equation and the recently developed ORNL creep equation; long-term ductility; and microstructural and hardness observations. (GHT)

1023 (ORNL/TM—6324) **Construction of creep-fatigue elastic-analysis curves and interim analysis of long-term creep-fatigue data for 2 1/4 Cr—1 Mo steel.** Booker, M.K. (Oak Ridge National Lab., TN (USA)). Jul 1978. Contract W-7405-ENG-26. 61p. AT.

Above 427°C (800°F), $2\frac{1}{4}$ Cr-1 Mo steel is one of only four materials currently approved under ASME Code Case 1592 for nuclear service. Still, Code Case 1592 does not include elastic-analysis creep-fatigue curves for this important material. This report details our efforts toward developing such curves. These efforts, including the use of the linear damage summation approach, were performed at the request of the ASME Working Group on Creep-Fatigue. Available creep-fatigue data were extrapolated using the linear damage summation approach to yield estimates of creep-fatigue cyclic lives corresponding to a total life of 250,000 hr. Appropriate safety factors were then applied to these curves to yield elastic-analysis curves. Possible effects of mean stresses on these curves were also investigated.

1024 (ORNL/TM—6441) **Program to calculate deformation mechanism maps using an HP-9821A calculator.** Coghlan, W.A. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

A program was written to calculate deformation mechanism maps by using a Hewlett-Packard 9821A calculator. This report describes the equations which are used to represent the strain rate resulting from the five mechanisms considered. A listing of the program is given along with a complete description of how it performs the calculations. Step-by-step instructions are also provided along with the data required to calculate two example maps. 2 figures, 1 table.

1025 (SAND—78-0453) **Dimensional stability of Ti—6Al—6V—2Sn.** Rack, H.J. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 21p. Dep. NTIS, PC A02/MF A01.

The dimensional stability of Ti-6Al-6V-2Sn has been examined. It is shown that in the duplex annealed condition Ti-6Al-6V-2Sn is dimensionally stable at temperatures up to 448°K for 512 hrs. Solution treated Ti-6Al-6V-2Sn undergoes large dimensional changes during both initial aging between 673 and 973°K and subsequent exposure to low temperatures (< or = to 448°K). These results indicate that if close dimensional tolerances must be maintained, duplex annealed Ti-6Al-6V-2Sn should be selected. Selection of treated and aged Ti-6Al-6V-2Sn should only be considered if accompanied by full scale environmental testing.

1026 (WARD-HT—3045-32) **Creep behavior of Type 304 SS under multiaxial stresses.** (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). Jun 1978. Contract EY-76-C-02-3045-006. 58p. AT.

A summary of all the results obtained on Type 304 SS are given along with discussion and interpretations of the results. Uniaxial and biaxial effective creep strain-time relations have been shown to be adequately represented by a single term exponential equation of the form used by Blackburn. Inaccuracies in such a representation are pointed out with reference to the material, manufacturing methods and product form used in the current work. It is shown that stress ratio effects on creep behavior could be significant although the single term exponential equation does not recognize the variable. The creep strains obtained are also compared with the uniaxial creep strains obtained at ORNL and B and W on other product forms of the same heat. It was observed that generally the specimens used at WARD are more resistant to creep and it is shown that this behavior can be attributed to the differences in annealing and manufacturing of specimens. It was also observed that for the same effective stress the biaxial creep strains are larger than the uniaxial creep strains. The report also contains the results of four step stress multiaxial tests designed to verify total creep strain creep hardening rule. It was observed that the hardening rule predicts the creep strains in step stress multiaxial tests with reasonable accuracy but definite conclusions on the validity of the hardening rule are difficult to draw.

1027 **Deformation and rupture behavior of Zircaloy cladding under simulated loss-of-coolant accident conditions.** Chung, H.M.; Garde, A.M.; Kassner, T.F. (Argonne National Lab., IL). *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 633, 82-97(1977).

Information on the diametral expansion and rupture characteristics of Zircaloy-4 cladding has been obtained in a vacuum environment over a wide range of internal pressures at several heating rates. The effect of axial constraint of the cladding, exerted by a mandrel that simulated the pellets in a fuel rod, on the relationship between the maximum circumferential strain and the burst temperature also was investigated. The circumferential strain for unconstrained cladding was significantly larger than for axially constrained tubes, particularly for burst temperatures below approximately 850°C, in which cladding remains essentially in the α-phase. Three superplastic strain peaks have been identified, namely, at rupture temperatures of approximately 850, approximately 1050, and approximately 1220°C. In the case of complete axial restraint, the failure strains were not dependent on heating rate for burst temperatures above approximately 920°C; however the low-temperature (approximately 850°C) strain peak increases and moves to lower temperatures as the heating rate decreases. The deformation data in this investigation also have been used to evaluate instability criteria proposed for thin-wall tubes under a biaxial stress state. The onset of plastic instability or local ballooning in the cladding has been defined in terms of the effective stress and strain during transient-heating conditions.

1028 **Statistical description of the microcracks that develop during the viscous fracture of molybdenum.** Rybin, V.V.; Vergazov, A.N. *Fiz. Met. Metalloved.;* No. 4, 858-865(1977). (In Russian).

Since the experimental data presently available in the literature on the initial stages of crack generation during viscous fracture and conclusions regarding the basis for the phenomenon are equivocal, the authors employed electron microscopy methods to find the distribution functions of microcracks with respect to dimensions, orientation, strain rate and external pressure on the fracture surface, outsides and interior of specimens of 99.9 percent pure molybdenum fractured by uniaxial tension at 2 . 10^{-3} sec^{-1} and T = 373°K (corresponding to the crest of the cold-shortness curve). Both emission (JEM-200A)and scanning (JSM-2) electron microscopes were used. The total plastic deformation of the bars from which the cylindrical specimens were prepared amounted to 75 percent. Before the mechanical testing, the molybdenum had a subgranular structure. It was found that just before fracture occurs the microcracks form on both sides of the fracture faces of the fragments and open up along the edges, primarily under the influence of internal tensile stresses. The time of formation of the microcracks amounts to 0.05—0.1 of the total time of deformation. 3 figures, 12 references.

1029 **Liquation of niobium and aluminum in welds of nickel alloys.** Bulatov, Yu.V.; Loseva, G.I. *Svar. Proizv.;* No. 5, 6-7(1977). (In Russian).

In the study of the liquation of niobium and aluminum as alloying elements in stainless nickel alloys, binary solid solutions of nickel with aluminum and niobium are considered here because of their narrow crystallization range, which increases the probability of hot cracking in the solid state. In the nickel solutions with low (3 percent at.) concentrations of the alloying element the niobium influences the reduction of the critical rate of deformation more strongly than does aluminum, and in solutions of higher concentrations causes practically no change of the resistance to hot cracking. This may be explained by the fact that as a result of the considerable boundary segregation of the niobium the solutions of such concentrations are not monophase, and the Ni_3Nb phase can form at the grain boundaries, thus the hot cracking is caused by a different mechanism. The very slight influence of the niobium on the resistance to hot cracking does not put a limit on its content in the alloys (within its limit of solubility in nickel). Since the aluminum in the binary solid solutions of nickel considerably reduces the critical rate of deformation its content in the solutions must be limited to 11 percent (at.). 5 figs., 2 tables, 10 refs.

1030 **Properties and heat treatment of Ti—Co and Ti—Co—Al alloys.** Moiseev, V.N.; Znamenskaia, E.V.; Danilina, T.G. *Met. Sci. Heat Treat. (USSR) (Eng. Transl.);* **17**: No. 3-4, 305-308(Sep 1975).

Binary and ternary titanium alloys with as much as 9 percent Co are investigated under various heat treatment conditions. It is shown that an increase in the cobalt content of annealed Ti-Co and Ti-Co-Al alloys leads to an increase in the ultimate strength and a decrease in ductility, that the increase in strength during aging is greatest for alloys containing 4 to 9 percent Co, and that the effect of martensitic hardening with quenching from temperatures above the critical temperatures is evident in alloys containing 2 to 4 percent Co. Aluminum enhances the strength of Ti-Co-Al alloys quenched to solid solution, both after quenching and after aging.

1031 **Creep of low-alloy molybdenum alloys.** Vinogradov, N.I.; Ermishkin, V.A.; Fridman, Z.G. (Inst. of Metallurgy, Moscow). *Met. Sci. Heat Treat. (USSR) (Eng. Transl.);* **17**: No. 3-4, 303-304(Sep 1975).

The creep resistance of molybdenum alloys containing small amounts of boron, lanthanum, tantalum, boron carbide, and hafnium + boron was investigated. Unalloyed molybdenum specimens were prepared for comparison. The investigation was conducted by the procedure proposed by Fridman and Geminov (1969) which is based on the possibility of single-valued correspondence between the results of standard tests and tests with programmed changes in creep rate. Results indicate that even small additions of alloying elements will increase the creep strength of molybdenum.

1032 Properties of tungsten alloys with carbon, niobium, tantalum, and zirconium. Pod'iachev, V.N.; Gavriliuk, M.I. *Met. Sci. Heat Treat. (USSR) (Eng. Transl.);* **17**: No. 3-4, 299-302(Sep 1975).

The mechanical properties of ternary W-Nb-C, W-Ta-C, and W-Zr-C alloys are investigated and compared to those of binary W-Nb, W-Ta, and W-Zr alloys at temperatures in the range 300 to 600°C and 1500 to 2000°C. Major conclusions are that alloying of W and W-C alloys with additions of Zr, Nb, and Ta increases stress- and creep-rupture strengths, that the alloying elements raise the ductile-brittle transition temperature of W and W-C alloys, and that at low temperatures the most effective alloying elements are carbon and group IV elements.

1033 Hot brittleness of Mo + 30% W. Ababkov, V.T.; Morgunova, N.N.; Guliaeva, T.V. *Met. Sci. Heat Treat. (USSR) (Eng. Transl.);* **17**: No. 3-4, 295-298(Sep 1975).

The hot brittleness of a molybdenum alloy containing 30 percent W is investigated for as-cast and deformed vacuum-melted alloy specimens. It is found that Mo + 30 percent W is susceptible to hot brittleness in the temperature range 1400 to 1800°C. Varying the tungsten content from 28 to 35 percent has little effect on the susceptibility of the alloy to hot brittleness, whereas addition of a small amount of Hf (about 0.2 percent) reduces susceptibility to hot brittleness. The results confirm earlier findings that hot brittleness of the alloy considered is due to the precipitation of a phase of the MO2C type in the grain boundaries.

1034 (NP-tr—2037) **Effect of cold forming on the creep rupture and creep behaviour of some high temperature steels.** Bohm, H.; Schirra, M. Translated from *Arch. Eisenhuettenwes.;* **44**: No. 10, 785-791(Oct 1973). 14p. British Library Lending Div., Yorkshire, Eng.

The effect of cold deformation on the stress rupture and creep behavior of some austenitic steels over a wide range is systematically investigated. (GHT)

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 643, 992, 996, 997, 1009, 1017, 1088, 1106

1035 (CONF-7805101—1) **Investigation of Pt^+ secondary ion yield enhancement observed in platinum and platinum—rhodium alloys.** Christie, W.H.; Kollie, T.G.; Eby, R.E. (Oak Ridge Y-12 Plant, TN (USA)). 1978. Contract W-7405-ENG-26. 3p. Dep. NTIS, MF A01.

From 26. conference on mass spectrometry and allied topics; St. Louis, MO, USA (28 May 1978).

Portions of document are illegible.

An ion microprobe was used to investigate the failure of sheathed Pt/Pt-Rh thermocouples. The particulars of this study have been detailed in two prior literature reports. In this study, it was observed that under the reducing conditions set up in the thermocouple the Pt and Pt-Rh thermoelements act as reducing agents for the MgO or Al_2O_3 used as insulation. Metallic Mg or Al then diffused into the Pt and Pt-Rh wires.

1036 (COO—1198-1213) **Upper critical magnetic field of superconducting films with magnetic impurities.** Lemberger, T.R. (Illinois Univ., Urbana (USA)). 5 Jul 1978. Contract EY-76-C-02-1198. 164p. Dep. NTIS, PC A08/MF A01.

Thesis.

The upper critical magnetic field, H/sub c2/(T), of In-Mn and Pb-Mn alloy films was measured. H/sub c2/ was determined from the resistance of the films. The results were compared with the theory of Fulde and Maki. This theory assumes that the electron-phonon coupling is weak, and that the interaction between the impurity spins and the conduction electron spins is weak. The theory predicts that the pair-breaking effect of the magnetic impurities is temperature-independent, and that the pair-breaking effects of the magnetic impurities and the applied magnetic field are additive. Furthermore, it predicts explicitly the temperature dependence of H/sub c2/. The temperature dependence of H/sub c2/ for the In-Mn alloy films is well described by the Fulde-Maki theory, despite the moderately strong electron-phonon coupling and the strong interaction between the impurity spins and the conduction electron spins. The temperature dependence of H/sub c2/ for the Pb-Mn alloy films is not well described by the Fulde-Maki theory, probably due to the strong electron-phonon coupling in Pb. However, even without a quantitatively correct theory, one can conclude from the Pb-Mn data that the pair-breaking effect of the magnetic impurities is temperature independent, and that the pair-breaking effects of the magnetic impurities and the applied magnetic field are additive. For some of the Pb-Mn alloy films, there was a region of positive curvature in H/sub c2/(T) near the zero-field transition temperature. This positive curvature is not understood.

1037 (IS-M—136) **Electronic contribution to anomalous phonon dispersion in Zr.** Harmon, B.N.; Stassis, C. (Ames Lab., IA (USA)). 1978. Contract W-7405-ENG-82. 5p. (CONF-780824—2). Dep. NTIS, PC A02/MF A01.

From 15. conference on low temperature physics; Grenoble, France (23 Aug 1978).

The temperature dependence of the [001]LO phonon branch in Zr is anomalous. At 6 K there is a dip in this branch at the zone center reminiscent of the anomalous dispersion observed in technetium—a high T/sub c/ superconductor. The anomaly can be related to electronic screening of the phonons. A simple model is proposed and the preliminary results of a frozen phonon calculation discussed.

1038 (LA-UR—78-1857) **High pressure study of ferromagnetic US.** Huang, C.Y.; Laskowski, R.J.; Olsen, C.E.; Smith, J.L. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 7p. (CONF-780823—1). Dep. NTIS, PC A02/MF A01.

From Conference on the electronic structure of the actinides; Grenoble, France (30 Aug 1978).

The variation of the ac magnetic susceptibility of a polycrystalline ferromagnet US as a function of hydrostatic pressure was investigated. The Curie temperature decreases linearly from 180.0°K at the atmospheric pressure to 175.9°K at 17.6 kbar.

1039 (SAND—78-0401C) **Materials compatibility in a thick film multilayer system.** White, S.S. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 9p. (CONF-780914—1). Dep. NTIS, PC A02/MF A01.

From International Society for Hybrid Microelectronics System; Minneapolis, MN, USA (25 Sep 1978).

Compatibility of materials in a thick film multilayer system was examined by stress, electron microprobe, insulation resistance, x-ray, and wet chemical analyses. The system consisted of EMCA 180 Pt-Au fritted conductor alternating with double-printed layers of Electroscience Laboratories 4608CFB crystallizable dielectric, on American Lava 96 percent Al_2O_3 substrates. The intent of the study was to discover what materials interactions could be expected after processing and to determine whether or not they were detrimental to the operation of the multilayer circuit, which is used in an ordnance controller. Various techniques were used to prepare samples for analyses. Residual stresses were calculated from physical properties of dielectric and substrate material, including thicknesses, thermal expansion coefficients, and Young's moduli of elasticity. Sample circuits were prepared for electron microprobe and insulation resistance analyses. These circuits were printed and fired to simulate processing of the ordnance controller circuit. However, after each stage of processing, unfinished sample circuits were removed from further processing for examination. These circuits were cross-sectioned and polished for microprobe analysis of materials interaction as a function of a number of firings. Insulation resistance studies were performed on both sample and actual multilayer circuits. In addition, x-ray analysis was performed on crystallized dielectric material to determine crystalline phases present. Wet chemical analyses were also performed on conductor and dielectric inks.

1040 (SRD—1023-1) **Study of mechanisms of hydrogen diffusion in separation devices. First annual report, August 1977—April 1978.** Lee, M.H. (Georgia Univ., Athens (USA). Dept. of Physics). 2 May 1978. Contract EG-77-C-09-1023. 8p. Dep. NTIS, PC A02/MF A01.

Hydrogen diffusion in palladium membranes was studied. The description of work performed includes: long-range nature of forces between absorbed H atoms in Pd and its effects on the diffusion process; a model for the energetics of a Pd-H system; and similarities between H diffusion in metal membranes and ion transport in biomembranes. (GHT)

1041 (UCRL—13881) **Research and development of stabilized multifilamentary Nb_3Sn superconductors. Technical report for the period, 12 September 1976 through 30 September 1977.** Ormand, F.T. (Airco, Inc., Murray Hill, NJ (USA). Central Research Labs.). 1977. Contract W-7405-ENG-48. 63p. Dep. NTIS, PC A04/MF A01.

An investigation of tensile properties of multifilamentary Nb_3Sn superconductors indicated that composites containing less than 12.5 volume percent (v/o) Nb_3Sn were usually ductile. Composites containing more than 12.5 v/o Nb_3Sn were brittle.

1042 Distribution function in nonequilibrium states of a superconductor. Willemsen, H.W.; Gray, K.E. (Argonne National Labora-

tory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **41**: No. 12, 812-815(18 Sep 1978).

We report the first measurements of the distribution function f of quasiparticles in a nonequilibrium superconductor. For a wide range of quasiparticle-injection energies, $f(E) \simeq [1 + \exp((E-\mu^*)/kT^*)]^{-1}$, where μ^* and T^* depend on the injection energy. Novel results include a negative μ^*, a T^* greater than the transition temperature, and a totally unanticipated bump in f at an energy of 3Δ, where Δ is the energy gap. This last result shows that detailed balance is violated in nonequilibrium states.

1043 Temperature dependence of the normal vibrational modes of hcp Zr. Stassis, C.; Zarestky, J.; Arch, D.; McMasters, O.D.; Harmon, B.N. (Ames Laboratory—United States Department of Energy and Departments of Physics and Metallurgy, Iowa State University, Ames, Iowa 50011). *Phys. Rev., B;* **18**: No. 6, 2632-2642(15 Sep 1978).

Inelastic-neutron-scattering techniques have been used to study the temperature dependence of the normal vibrational modes of hcp Zr. The phonon spectra along the [001], [100], and [110] symmetry directions were determined at 295, 773, and 1007 K. The [001] LO branch and a selected number of phonons of other branches were determined also at 5.5 K. As the temperature decreases we observe a rather large increase in the frequencies of all but the [001] LO branch. The zone-center mode of the [001] LO branch softens appreciably and at 5.5 K this branch exhibits a dip at the zone center reminiscent of the anomalous dispersion of the corresponding branch of technetium at room temperature. The data were used to evaluate the lattice specific heat at constant pressure as a function of temperature. The calculated total specific heat at constant pressure, obtained by taking into account the electronic contribution, was found to be consistent, to within experimental uncertainties, with the results of specific-heat measurements. We propose an explanation for the softening of the zone-center mode of the [001] LO branch and the large increase in the frequencies of the other modes with decreasing temperature which is based on the electronic structure of Zr.

1044 Nonlinear electron-density distribution around point defects in simple metals. I. Formulation. Gupta, A.K.; Jena, P.; Singwi, K.S. (Physics Department and Materials Research Center, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B;* **18**: No. 6, 2712-2722(15 Sep 1978).

Modification, which is exact in the limit of long wavelength, of the nonlinear theory of Sjoelander and Stott of electron distribution around point defects is given. This modification consists in writing a nonlinear integral equations for the Fourier transform γ_{12} (q) of the induced charge density surrounding the point defect, which includes a term involving the density derivative of γ_{12} (q). A generalization of the Pauli-Feynman coupling-constant-integration method, together with the Kohn-Sham formalism, is used to exactly determine the coefficient of this derivative term in the long-wavelength limit. The theory is then used to calculate electron-density profiles around a vacancy, an eight-atom void, and a point ion. The results are compared with those of (i) a linear theory, (ii) Sjoelander-Stott theory, and (iii) a fully self-consistent calculation based on the density-functional formalism of Kohn and Sham. It is found that in the case of a vacancy, the results of the present theory are in very good agreement with those based on Kohn-Sham formalism, whereas in the case of a singular attractive potential of a proton, the results are quite poor in the vicinity of the proton, but much better for larger distances. A critical discussion of the theory vis a vis the Kohn-Sham formalism is also given. Some applications of the theory are pointed out.

1045 Coherent-potential-approximation calculations for PdH/sub x/. Papaconstantopoulos, D.A.; Klein, B.M.; Faulkner, J.S.; Boyer, L.L. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Rev., B;* **18**: No. 6, 2784-2791(15 Sep 1978).

The angular-momentum components of the density of states (DOS) for substoichiometric PdH/sub x/ were calculated by the coherent-potential approximation (CPA). A tight-binding form of the CPA was used, based on a Slater-Koster fit to first-principles APW calculations. The CPA DOS's have been used to calculate the electron-phonon interaction and superconducting transition temperatures as a function of hydrogen concentration x. The results are in good agreement with experiment and with previous calculations in which the rigid-band model was utilized. The CPA results for the electronic-specific-heat coefficient as a function of x are in excellent agreement with experiment while the results of the rigid-band model are not.

1046 Critical-point and critical-line analysis of impurity-induced first-order Raman scattering in KBr and KCl. Just, S.; Yacoby, Y. (Racach Institute of Physics, Hebrew University, Jerusalem, Israel). *Phys. Rev., B;* **18**: No. 6, 2918-2924(15 Sep 1978).

The wavelength derivative Raman scattering spectra of KBr:Tl and KCl:Tl at 90 K are interpreted in detail in terms of scattering by phonons at Van Hove critical points of the host crystal. In this interpretation the line shape is used as one of the criteria, together with energy and selection rules, in identifying an experimental structure with a critical point. In addition to critical points which are symmetry required and on symmetry lines, we find several critical points which have a symmetry of only one mirror plane. It is shown that the largest structure of each of the spectra results from scattering by phonons on a critical or almost critical line. Such critical lines exist in many rock salt crystals but not in all. The conditions for the existence of a critical line are discussed.

1047 Dechanneling by dislocations in ion-implanted Al. Picraux, S.T.; Rimini, E.; Foti, G.; Campisano, S.U. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev., B;* **18**: No. 5, 2078-2096(1 Sep 1978).

The first comprehensive ion-backscattering study of the influence of dislocations on the dechanneling of energetic channeled ions has been carried out. High dislocation densities were obtained in the near-surface region of single-crystal Al by implantation of 6.6×10^{16} Al/cm^2 or 2.6×10^{16} Zn/cm^2. Independent analysis of the disorder introduced by the Al and Zn implantations, as well as a quantitative measure of the total length of dislocation lines per cm^2, were obtained by transmission-electron microscopy. Dechanneling measurements were made by means of ion backscattering for H^+ and He^+ ions ranging in energy from 0.5 to 2.8 MeV, incident along the <110> axial and {111} planar channeling directions. For these experimental parameters a systematic dependence of the dechanneling versus depth is demonstrated. These experimental observations are characteristic of that predicted theoretically for dechanneling by dislocations and distinctly different from that observed for randomly displaced atoms. The theoretical analysis for the data reduction is developed to obtain the dechanneling cross section for dislocations from the experimental data for both axial and planar channeling. The results are in agreement with independent theoretical calculations of the dislocation dechanneling cross section by Quere, both quantitatively and in the functional dependences of the dechanneling parameter on energy, ion type, and channeling direction. From these studies the measurement of dislocation density by single alignment channeling is estimated to require 10^9—10^{10} dislocation lines per cm^2. Although axial channeling has been used in the past for depth profiling measurements of disorder by backscattering, the large dechanneling cross sections and well-defined dechanneling behavior shown here for planar channeling suggest that planar analysis may be more suitable than axial for determining the depth distribution of dislocations by channeling-effect measurements.

1048 Structure of layer produced on a surface of aluminum when a magnetic field H>H/sub c/ is turned on. Dolgopolov, V.T.; Dorozhkin, S.I. (Institute of Solid State Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 8, 430-433(20 Apr 1978).

A microscopic study is made of the structure of the layer. It is observed that the layer is close in its structure to a two-dimensional mixed state of a type-I superconductor [L. D. Landau, private communication to D. Shoenberg (see D. Shoenberg, Superconductivity, Cambridge Univ. Press, 1938, p. 50); L. P. Gor'kov and O. N. Dorokhov, Sov. Phys. JETP 40, 956 (1975); A. F. Andreev and Yu. K. Dzhikaev, JETP Lett. 26, 590, (1977)].

1049 Superconductivity of tribolayers formed on germanium by friction between germanium and lead. Dukhovskoi, A.; Karapetyan, S.S.; Morozov, Y.G.; Onishchenko, A.S.; Petinov, V.I.; Ponomarev, A.N.; Silin, A.A.; Stepanov, B.M.; Tal'roze, V.L. (All-Union Research Institute for Optical—Physical Measurements). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 7, 384-386(5 Apr 1978).

A superconducting state was observed for the first time in tribolayers of germanium produced by friction of germanium with lead at 42 K. The maximum value of T/sub c/ obtained in the experiment was 19 K, which is much higher than T/sub c/ of bulk lead itself or of lead films sputtered on germanium.

1050 Tunneling in binary alloys. Borodai, B.I.; Svistunov, V.M. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Donetsk). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 4, 585-589(Apr 1978).

The effect of the phase composition of alloys on superconducting tunneling was studied experimentally in the Pb—Bi system. The application of pressure up to 14 kbar together with stepwise annealing up to 370°K followed by quenching to 4.2°K enabled us to show that for Pb alloys with 10—63 at.% Bi the multiphase nature of the alloys is directly reflected in the tunneling characteristics. For alloys beyond the eutectic composition (>60%Bi) quenched from above 100°C, we observed characteristics typical of pure metals, which we associate with a range of existence of the single-phase composition which is wider than that in the accepted phase diagram.

1051 Metastable current states in superconducting thin films. Galkin, A.A.; Ivanchenko, Y.M.; Khirnyi, V.F. (Physicotechnical

Institute, Academy of Sciences of the Ukrainian SSR, Donetsk). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 4, 713-714(Apr 1978).

1052 Auger electron spectroscopic study of the diffusion of sulfur, carbon, and chlorine in powdered titanium. Lofton, C.P.; Swartz, W.E. Jr. (General Electric Co., St. Petersburg, Florida 33733 and Department of Chemistry, University of South Florida, Tampa, Florida 33620). *Appl. Spectrosc.;* **32**: No. 2, 177-181(Mar 1978).

Auger electron spectroscopy has been employed to study the diffusion of sulfur, carbon, and chlorine in powdered α-titanium. Arrhenius analysis of the diffusion rates indicates that the activation energies are 15.5, 6.2, and 9.8 kcal/mol for sulfur, carbon, and chlorine, respectively. These activation energies are consistent with diffusion along grain boundaries with the α-titanium.

1053 Oscillations of energy gap of superconducting vanadium—carbon sandwiches. Tsetlin, M.B.; Mikheeva, M.N. *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 3, 178-181(5 Feb 1978).

Tunnel spectroscopy was used to measure the energy gap of superconducting vanadium—carbon sandwiches. It turned out that the gap oscillates in phase with the critical temperature and, furthermore, there are grounds for assumin that the ratio 2Δ/kT/sub cr/ behaves in similar fashion.

1054 Influence of hydrogen on the low temperature heat capacity of lutetium-rich lutetium-hydrogen alloys. Thome, D.K.; Gschneidner, K.A. Jr.; Mowry, G.S.; Smith, J.F. (Ames Lab., IA). *Solid State Commun.;* **25**: 297-301(1978).

The low temperature (1—20°K) heat capacity results of lutetium containing up to 15.5 at. % H in solid solution were measured. In alloys containing between 0.1 and <3.0 at. % H a low temperature anomaly was observed in the C/T vs. T^2 plots below 2.5°K, but alloys containing 3.0 or more at. % H were linear down to the lowest temperature measured. The electronic specific heat constant, γ, initially increased by approximately 35% when 1.5 at. % H was added, and then γ decreased at higher hydrogen concentrations. The Debye temperature, theta/sub D/, may also show a similar variaton. These anomalous behaviors are thought to be due to hydrogen tunneling.

1055 Study of the temperature dependence of the probabilities of emission and absorption of resonance γ rays by ^{182}W without loss of energy to recoil. Kaipov, D.K.; Makhanov, U.M.; Kuz'minov, A.V.; Adymov, Z.I.; Aspandiyarov, A.T. (Nuclear Physics Institute, Kazakh Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1066-1068(Dec 1977).

The current method of γ-ray detection has been used to measure the Moessbauer effect in the 100.1-keV level of ^{182}W in the absorber temperature range 109—255 K at a constant source temperature of 89 K and in the range of source temperatures 93.5—160 K at a constant absorber temperature of 101 K. We have determined the temperature dependence of the probability of absorption and emission of resonance γ rays by ^{182}W without loss of energy to recoil, and the Debye temperatures of metallic tungsten and tantalum.

1056 Interaction between vortices and the surface of a type II superconductor and the field of a vortex in a cavity. Abramyan, A.T.; Shmidt, V.V. (Institute of Solid State Physics, Academy of Sciences USSR). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1185-1190(Dec 1977).

The response of a hollow, thin-walled Pb+30 at.% In superconducting cylinder in the mixed state to an external weak alternating magnetic field is investigated experimentally. It is found that vortices located near the inner surface of the cylinder produce a magnetic field in the cavity of the cylinder. In response to an external alternating field, the vortices adjacent to the outer surface of the cylinder execute reversible oscillations until their amplitude reaches a certain critical value, which is proportional to the period of the vortex lattice. This state corresponds to the flow of a critical current along the outer surface of the cylinder. The vortex oscillation amplitude in this case is of the order of several angstroms for vortices adjacent to the inner surface of the cylinder. The interaction between the vortices and the surface of the superconductor depends on the modulus of rigidity k, in accord with Eq. (3). The proportionality coefficient between the oscillation amplitudes for the outer and inner vortices is proportional to the external magnetic field.

1057 Effect of cooling type-I superconductors in the dynamic intermediate state. Sharvin, Y.V.; Broneva, I.L. (Institute of Physics Problems, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1191-1194(Dec 1977).

The temperature difference T_1—T_2 produced between the ends of a cylindrical intermediate-state sample as a result of longitudinal motion of the superconducting and normal domains under the influence of a current J at Tvery-much-less-thanT/sub c/ have been calculated and measured. The problem of the temperature distribution in the sample is solved in general form under the assumption that the thermal conductivity has a cubic dependence on the temperature. For an indium sample of 4 mm diameter and an approximate electron mean free path in the normal phase 10 mm the results of measurements at T=0.34 +- 0.01 K are in approximately sufficient agreement with the calculations by the parabola T_1—T_2 =-4 x 10^{-5}J+1.5 x $10^{-5}J^2$, where J is in amperes. The distance between the thermometers on the sample was 8 cm.

1058 Type I superconductors in a high-amplitude, low-frequency alternating field. Dolgopolov, V.T.; Murzin, S.S. (Institute of Solid State Physics, Academy of Sciences USSR). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1195-1199(Dec 1977).

We studied experimentally the destruction of superconductivity in long cyclindrical samples of tin and indium by a magnetic field parallel to the axis of the cylinder and in the presence of an alternating electromagnetic field of large magnitude. Frequencies were employed at which the skin depth in the normal state was much less than the thickness of the sample. It is shown that as a result of the periodic process accompanied by the transitions on the surface, from the superconducting to the normal state, and vice versa, the magnetic induction flux is crowded into the interior of the sample. Because of this crowding, the transition of the entire sample to the normal state under the influence of the alternating field occurs in an external field H<H/sub c/.

1059 Superconductivity and structural instability of the ZrV_2 compound. Finkel', V.A.; Pushkarev, E.A. (Physicotechnical Institute, Ukrainian Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1220-1222(Dec 1977).

The electrical resistivity between 60 and 300 K and the superconducting transition temperature T/sub c/ are measured for samples of Laves-phase ZrV_2 with a C15 structure in quenched and annealed states. It is found that a structural transformation occurs at ~90 K in the annealed samples, whereas their T/sub c/ is 0.3° lower than for the quenched samples. The appearance of lattice instability and the lowering of T/sub c/ as a result of annealing at 1200 °C is ascribed to an increase in the degree of atomic ordering in the crystal lattice of the ZrV_2 compound.

1060 Nonlinear variation of the energy gap and the phonon spectrum of indium near the electron transition. Svistunov, V.M.; Revenko, Y.F. (Donets Physico-Technical Institute, Ukrainian Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 947-952(Nov 1977).

The method of electron tunneling is used to investigate the electron-phonon interaction and the phonon spectrum of indium in a wide range of pressures and tin-impurity concentrations. An anomalous behavior of the lattice-vibrational spectrum is discovered in the region topolgical changes in the Fermi surface. The possible mechanisms leading to such changes in the lattice are considered.

1061 Surface impedance of cadmium in a magnetic field. Voloshin, I.F.; Skobov, V.G.; Fisher, L.M.; Chernov, A.S.; Yudin, V.A. (All-Union Electrotechnical Institute). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 989-995(Nov 1977).

The behavior of the surface impedance of cadmium is investigated theoretically and experimentally in the range of Doppler-shifted cyclotron resonance. It is found that the reactance of the metal has minima in the neighborhood of the thresholds of various dopplerons. The experimental data agree with the theoretical results for the case of diffuse reflection of the electrons by the surface.

1062 Matrix behavior in copper—tungsten composites at small strains. Chawla, K.K. (Instituto Militar de Engenharia, Rio de Janeiro, Brazil); Metzger, M. *Metall. Trans., A;* **8A**: 1681-1687(Nov 1977).

Composites with up to 15 pct tungsten wires in a copper crystal matrix prepared by infiltration showed matrix microyield and flow stresses increasing with fiber fraction. Dislocation etch-pit observations showed that the walls of a cell structure in the matrix formed during fabrication were the operative dislocation obstacles and that this initial structure rather than fiber-matrix interaction during straining was responsible for the matrix strengthening.

1063 Determination of absolute atomic transition probabilities using time resolved optical pumping. Carlson, L.R.; Johnson, S.A.; Worden, E.F.; May, C.A.; Solarz, R.W.; Paisner, J.A. (Univ. of California, Livermore). *Opt. Commun.;* **21**: No. 1, 116-120(Apr 1977).

We describe a method of determining atomic transition probabilities by independently measuring branching ratios and radiative lifetimes. These quantities are directly determined by time resolved optical pumping. The technique has been applied to the measurement of gA values for particular transitions in ^{238}U I.

1064 Deformation behaviour and shape memory effect of near equi-atomic NiTi alloy. Mohamed, H.A.; Washburn, J. (Lawrence Berkeley Lab., CA). *J. Mater. Sci.;* **12**: 469-480(1977).

The mechanical shape memory effect associated with the martensitic-type transformation which occurs in polycrystalline Ti—50.3 at. % Ni alloy has been investigated using the techniques of transmission and optical microscopy. Deformation of initially partially transformed material within the recoverable strain range was found to occur by: (1) stress-induced transformation of the most favorably oriented existing martensite variants at the expense of adjacent unfavorably oriented variants and retained high temperature phase, (2) stress-induced re-orientation of favorably oriented martensite by utilizing the most favorably oriented twin system, and (3) stress-induced twin-boundary migration within the martensite. The reverse transformation during heating restores the original grain structure of the high-temperature phase in a highly coherent manner. It was concluded that deformation modes limited to those involved in the transformation process and the reversibility of the transformation give rise to the memory effect.

1065 Bias potential effects on the anisotropic electroreflectance of single crystal silver. Furtak, T.E.; Lynch, D.W. (Ames Lab., IA). *J. Electroanal. Chem.;* **79**: 1-17(1977).

After a review of the field of metallic electroreflectance (e.r.), a report is presented on an experimental study of electrode bias potential effects on the normal incidence e.r. of carefully prepared [110] Ag, at a 1 M KOH interface, using a drop electrolyte technique, in the potential range -0.1 to -1.2 V (SCE), with polarized light in an energy range from 3.0 to 4.2 eV. The previously reported polarization anisotropy is well characterized in the potential range -0.3 to -0.9 V, but disappears near the potential of zero charge (p.z.c. = -1.0 V, SCE). This fact, together with the demonstrated good fit of our data to the McIntyre-Aspnes charge modulation theory, which ignores symmetry effects, leads us to the conclusion that near the p.z.c., electrons at normal metallic densities screen out low frequency fields, whereas when the surface electron density is decreased, at more positive potentials, the field can penetrate into a region having periodic crystal structure. Shifts in the location of e.r. peaks as well as reversals in their polarization dependence are attributed to alterations of the electron states in the surface region.

1066 Thermophysical properties of liquid tantalum and molybdenum. Shaner, J.W.; Gathers, G.R.; Minichino, C. (Lawrence Livermore Lab., CA). *High Temp. - High Pressures;* **9**: 331-343(1977).

A recently developed technique for thermophysical measurements on resistively heated metals has been applied to liquid tantalum and molybdenum. Data on the properties, including specific heat, thermal expansion, and electric resistivity, are reported up to 7500°K for tantalum and 4300°K for molybdenum. The pressure derivatives of the melting temperatures have been calculated, and the temperature dependence of the bulk modulus is estimated for the liquid phase of tantalum.

1067 Structural aspects of one-dimensional conductors. Stucky, G.D. (Univ. of Illinois, Urbana); Schultz, A.J.; Williams, J.M. *Annu. Rev. Mater. Sci.;* **7**: 301-339(1977).

This review emphasizes recent advances in the investigation of the structural aspects of 1-D conductors. The discussion is limited to the early transition metal complexes, the organic charge-transfer complexes, and the partially oxidized transition metal d^8 complexes. Since our goal has not been to provide a totally comprehensive survey, many interesting materials which have electronic properties that are 3-D but have some 1-D structural character, such as (SN)/sub x/ (2) and $Hg_{2.86}AsF_6$ (3), are not included within the scope of this review. In order to define certain terms and concepts, a brief introduction to the basic theories of 1-D conductivity is given in the following section.

1068 Quadrupole interaction in zinc metal. Vetterling, W.T.; Pound, R.V. (Harvard Univ., Cambridge, MA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 27-28(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

To allow measurement of the quadrupole interaction in zinc metal, the enriched ZnO was reduced to zinc metal powder and compressed into a pill of thickness 1.4 gm/cm². Sources were made by diffusing 20 mCi of ^{67}Ga into sintered copper pills. The transducer was based on a cylinder of PZT-4 with $^1/_2$-inch length and could cover linearly a velocity range of +-100 μ/s at 200 Hz. The multiscalar was a modified Northern model NS600, with a minimum dwell time of 20 μs, and with a 10-count buffer at the input to eliminate deadtime from memory cycling (for count rates of up to about 3 x 10^5 counts/s).

1069 Moessbauer studies in a ^3He—^4He dilution refrigerator: search for nuclear cooperative phenomena. Triplett, B.B.; Dixon, N.S.; Mahmud, Y.; Hanna, S.S. (Stanford Univ., CA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 118-129(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Materials containing ^{141}Pr and ^{169}Tm were studied in the dilution refrigerator, most progress being made with ^{169}Tm. Experimental techniques are described, and results are given for the hyperfine interactions in Tm compounds known to order magnetically. The studied materials are thullium metal, $TmAl_2$, TmS, and TmSe. 6 references. (JFP)

1070 Moessbauer measurements at very low temperatures. Bogner, L.; Gierisch, W.; Potzel, W.; Litterst, F.J.; Kalvius, G.M. (Technische Universitaet Muenchen, Garching, Ger.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 130-139(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Two applications of very low temperatures to Moessbauer spectroscopy recently carried out are described.

1071 Vickers hardness measurements of unidirectionally solidified Al—Si eutectic alloy grown at different rates. Justi, S.; Bragg, R.H. (Univ. of California, Berkeley). *Metall. Trans., A;* **7**: 1954-1958(Dec 1976).

An important commercial material is the Al-Si piston alloy. It consists mainly of the Al-Si eutectic modified with small additions of Cu and Mg to improve the strength by metastable precipitation, and Ni to improve the high temperature strength. A disadvantage of these precipitation hardening alloys is the significant decrease in strength in the 150 to 250°C temperature range due to dissolution of the precipitates. Other means to improve high temperature properties of aluminum alloys, such as addition of oxide dispersions in the Al matrix, have been successful, but require expensive sintering processes. It is of interest to determine if directional solidification can improve the mechanical properties of the Al-Si eutectic alloy. The Al-Si eutectic is of the faceted-nonfaceted type, according to the classification of Hunt and Jackson. In conventional casting at high freezing rates, it is found that the Si phase grows independently into the melt ahead of the Al phase with no noticeable coupling to it. This results in a microstructure in which the eutectic Si occurs as more or less randomly oriented needles or irregular plates in the Al matrix. Directional solidification at low rates produces "fiber" alignment, but the fibers have a complicated cross section first described by Day and Hellawell. In this work studies are reported of the microstructures and hardness of the unmodified Al-Si eutectic which has been directionally solidified at different growth rates.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 40, 48, 71, 371, 579, 755

1072 Role of surface studies in science and technology. Karkhanavala, M.D. (Bhabha Atomic Research Centre, Bombay (India). Chemistry Div.). pp 1-16 of Proceedings of the symposium on chemistry and physics of surface of metals and their oxides. Bombay; Department of Atomic Energy (1977).

From Symposium on chemistry and physics of surface of metals and their oxides; Kalpakkam, Tamil Nadu, India (27 Jan 1976).

Reactivity of solids is influenced by the surface properties such as structure, dislocations and composition. Corrosion and erosion are essentially surface phenomena. Surface studies, therefore, assume importance in prevention and minimization of corrosion and erosion. Discussion is illustrated with examples drawn from the field of nuclear power reactor technology.

1073 (FE—2621-2) Evaluation of high chromium overlays to protect less alloyed substrates from corrosion in a coal gasification atmosphere. Quarterly report, December 1, 1977—February 28, 1978. Sadowski, E.P. (International Nickel Co., Inc., Suffern, NY (USA). INCO Research and Development Center). 1978. Contract EF-77-C-01-2621. 31p. Dep. NTIS, PC A03/MF A01.

One-half of the welding is complete and testing started on this program to produce overlays with corrosion resistance to coal gasification atmospheres at 1800°F. In the last quarter, single and double layer overlays were deposited with INCONEL Filler Metal 72 (44 percent Cr) on 304L, 310 and INCOLOY alloy 800H with the submerged-arc (SAW) and hot wire gas tungsten arc processes (GTAW-HW), and on 304L with the gas metal arc process. In addition, the experimental R139 filler metal (31Cr-3Al) was overlaid on 304L with the SAW process. Percent dilution of the base plate was measured and percent recovery of the major alloying elements were calculated for the AWS-ER309 overlays on 304L for all weld processes and for the R139 overlaid on 304L by the SAW process. Pre-exposure testing of the AWS-ER309 overlays on 304L was completed and stress rupture testing started. The tests consisted of hardness surveys, bend and tensile tests, bulk chemical analysis of the overlay and microprobe analysis for the distribution of the major alloying elements from the outside edge of the overlay through the

thickness of the base plate. Inspection of the weldments was by dye-check and examination of cut slices.

1074 (GEAP—12697) **Detection of sensitization in stainless steel. II. EPR method for nondestructive field tests.** Clarke, W.L.; Romero, V.M. (General Electric Co., San Jose, CA (USA). Nuclear Technology Dept.). Feb 1978. 56p. Dep. NTIS, PC A04/MF A01.

A program is in progress to develop a quantitative method (Electrochemical Potentiokinetic Reactivation) for nondestructively measuring the degree of sensitization in Types-304 and -304L stainless steels. The technique has been extended to characterize weld heat-affected zones and to correlate degree of sensitization with intergranular stress corrosion cracking resistance. A portable electrochemical cell and polarization system were developed and qualified for obtaining EPR measurements in-situ, on components in the field. A specification was issued for conducting an EPR test in the laboratory and procedures were initiated to conduct a round robin test for adoption of the EPR method by ASTM as a standard practice.

1075 (LBL—8044) **Catalysis by platinum single crystal surfaces: low pressure hydrocarbon reactions and the effects of introducing strongly bound oxygen at the surface.** Smith, C.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1978. Contract W-7405-ENG-48. 184p. Dep. NTIS, PC A09/MF A01.

Thesis.

The dehydrogenation of cyclohexene and cyclohexane, and the hydrogenation of cyclohexene were studied on the clean and preoxidized surfaces of three platinum single crystals: a Pt(111), a stepped Pt(S) - [6(111) x (100)] and a kinked Pt(S) - [7(111) x (310)]. The choice of reaction conditions is discussed with respect to detection limits and the variation of the catalyst reactivity with reagent pressures and catalyst temperature; the reactions were carried out using flow conditions at low pressure (10^{-6} to 10^{-5} torr total pressure), at a platinum temperature of 150°C. Oxygen coverages were monitored by Auger electron spectroscopy (AES), an Auger peak ratio of $O_{510}/Pt_{237} = 0.5$ having been determined to correspond to approximately 5×10^{14} oxygen atoms/cm^2. The surface structures of the clean and oxidized platinum crystals were determined by low energy electron diffraction (LEED): after high temperature (800°C) oxygen treatment, the predominant oxygen structure observed on the Pt(111) was a (2 x 2); the predominant oxygen structure observed on both the Pt(S) - [6(111) x (100)] and the Pt(S) - [7(111) x (310)] was a (radical 3 x radical 3) - R30°. Low coverages of strongly bound oxygen enhanced the rates of the dehydrogenation and hydrogenation reactions, and changed the selectivity of cyclohexene dehydrogenation to benzene over hydrogenation to cyclohexane. These effects of preoxidation on catalytic rates and selectivity were found to be sensitive to the structure of the platinum surface, kink sites playing a particularly active role in the enhancement of dehydrogenation and hydrogenation activity by strongly bound oxygen. Three models are discussed which relate the oxidation of platinum surfaces to the observed effects on catalytic reactivity and the structure sensitivity. A change in the electronic structure of the platinum surface through oxidation provides the best general model for explaining the oxygen effects.

1076 (SAND—78-8675) **Hydrogen induced ductility losses in austenitic stainless steel welds.** Brooks, J.A.; West, A.J. (Sandia Labs., Livermore, CA (USA)). Jun 1978. Contract EY-76-C-04-0789. 28p. Dep. NTIS, PC A03/MF A01.

The effect of hydrogen on the tensile behavior of austenitic stainless steel welds was studied in two AISI 300 series alloys and two nitrogen strengthened alloys. The microstructure of these welds typically contained several percent ferrite in an austenite matrix. Hydrogen was found to reduce the ductility of all welds; however, the severity of ductility loss decreased with increasing stacking fault energy, as observed in previous studies on wrought material. In the lowest stacking fault energy welds, 304L and 308L, hydrogen changed the fracture mode from simple rupture to a mixed mode of ductile and brittle fracture associated with the austenite ferrite interface. Higher stacking fault energy welds, 309S and 22-13-5, showed smaller losses in ductility. In these materials hydrogen assisted the ductile rupture process by aiding void growth and coalescence, without changing the fracture mode. Varying the amount of ferrite from approximately one to 10 percent had no significant effect on performance in hydrogen.

1077 (ZJE—200) **Some remarks on the analysis of stress-corrosion cracking of austenitic stainless-steel cladding.** Kupka, I.; Nrkous, P. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1977. 17p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Stress-corrosion cracking is greatly influenced by tensile stresses in the material. The occurrence of tensile stresses in the material under consideration results from residual stresses brought about during manufacturing processes and from stress caused by operation. In the case of an austenitic steel cladding the residual stresses arise in the course of welding and thermal treatment. The technique of residual stress measurement in austenitic cladding materials is described and the results are given. Both the longitudinal and transverse components of the stresses show in all cases similar behavior not only prior to, but also after heat treatment.

1078 **Heat treatment protects steel alloys from hot gases.** Arnold, J.L. (Armco Steel Corp, Middletown, Ohio). *Chem. Eng. (N.Y.);* **85**: No. 11, 205-206, 208(8 May 1978).

Exposure of metal parts and equipment to destructive carburizing or sulfidizing environments is a hazard encountered in many high-temperature operations. Some of the more extreme applications crop up in the processing of hydrocarbons (e.g., ethylene production), metal working (gaseous and vacuum carburizing; carbonitriding), nuclear power generation (gas- and liquid-cooled reactors), and coal gasification and liquefaction. Many materials that might otherwise be useful will react with these environments, resulting in the pickup of carbon or sulfur. This leads to degradation of both the mechanical properties and the corrosion- and oxidation-resistance of the materials. This paper presents results of a test program which was carried out to assess the value of heat-treating an aluminum-bearing, ferritic stainless steel to improve its corrosion resistance at high temperature. Experimental data are tabulated, plotted and evaluated.

1079 **Effect of a high heat flux on the corrosion of 2-1/4 Cr-1 Mo steel in superheated steam.** Griess, J.C. (Oak Ridge National Lab., TN); DeVan, J.H.; Maxwell, W.A. *Mater. Performance;* **17**: No. 1, 9-15(Jan 1978).

A series of corrosion tests was conducted to determine the effect of heat flux on the corrosion of 2¼ Cr-1 Mo steel in superheated steam. The tests were conducted with a constant heat flux of 126 kW/m^2 (40,000 Btu hr^{-1} ft^{-2}) and surface temperatures varying from 510 to 541°C (950 to 1000°F) on each specimen. Specimens were exposed for varying periods, ranging from 500 to 6000 hours. Essentially all the corrosion product oxide remained on the steel during the first 2000 hours, but after that time, exfoliation of the oxide began. The percentage of corrosion product oxide lost from the specimen increased with exposure time, and about 33% was missing after 6000 hours. After an initial period of rapid corrosion, the average corrosion rate was constant at 45 μm/year (1.8 mils/year). In contrast, isothermal specimens exposed to superheated steam at 499°C (930°F) in the same test facility corroded at a decreasing rate throughout the test. Metallographic sections showed that, with heat transfer across the specimen-steam interface, both cracks and porosity developed in the oxide, even on short exposure, a fact that was undoubtedly responsible for the early exfoliation of the oxide and the constant corrosion rate.

1080 **Comparison and interpretation of fracture surfaces produced in Ti-8Al-1Mo-1V by stress-corrosion cracking and slow-strain-rate hydrogen embrittlement.** Koch, G.H.; Bursle, A.J.; Pugh, E.N. (Univ. of Illinois, Urbana). *Metall. Trans., A;* **9A**: 129-131(Jan 1978).

Two opposing views exist to account for the SCC of the near-α Ti-8Al-1Mo-1V, namely preferential anodic dissolution and hydrogen-induced cleavage. This communication provides support for the latter by comparing the fracture surfaces produced by SCC and by slow-strain-rate hydrogen embrittlement, a process known to occur by mechanical fracture. In addition, it demonstrates that the often complex fracture surfaces can be readily interpreted in terms of a cleavage model.

1081 **Sulfur segregation to gain boundaries in Ni_3Al and $Ni_3(Al,Ti)$ alloys.** White, C.L. (Oak Ridge National Lab., TN); Stein, D.F. *Metall. Trans., A;* **9**: 13-22(Jan 1978).

The segregation of S to grain boundaries in Ni_3Al and $Ni_3(Al, Ti)$ has been studied using Auger electron spectroscopy. The S concentration at the grain boundaries decreases more slowly with increasing temperature than would be predicted by segregation models based on a single solute binding energy to the grain boundaries. This behavior, which can be interpreted as an increase in the effective solute binding energy for a grain boundary as a function of temperature, is consistent with predictions of a model based on the existence of a spectrum of solute binding energies for grain boundaries.

1082 **Chemical and physical changes at sodium-stainless steel interfaces in fast reactors.** Mathews, C.K. (Bhabha Atomic Research Centre, Bombay (India). Radiochemistry Div.). pp 77-90 of Proceedings of the symposium on chemistry and physics of surface of metals and their oxides. Bombay; Department of Atomic Energy (1977).

From Symposium on chemistry and physics of surface of metals and their oxides; Kalpakkam, Tamil Nadu, India (27 Jan 1976).

In the sodium loops of a fast reactor, mass transfer occurs due to the interaction of flowing sodium on stainless steel surfaces. Under the non-isothermal conditions prevailing in the loop some elements are preferentially leached from the surface layers of the hot

zone and transported by sodium to the cooled zone where deposition may take place. The available information on the mass transport in non-isothermal sodium loops has been summarised, and an attempt has been made to understand the mechanisms involved, of which the chemical reactions at the sodium-stainless steel interface are especially important. The rate of diffusion towards the solid/liquid interface may be the rate-determining step in some of these reactions. When a ferritic surface layer is formed by the selective removal of austenitic stabilizing elements, diffusion of alloying constituents through the ferritic layer limits the growth of this layer. Only when the surface film is adherent, the diffusion across this layer becomes important. $NaCrO_2$, for instance, has poor adherence, and a surface film of this compound may not inhibit further corrosion.

1083 Analysis of specimen fixture interaction for slow crack-growth studies. Jones, A.T.; West, A.J. (Sandia Labs., Livermore, CA). *Eng. Fract. Mech.;* 9: 5-15(1977).

The self-loading procedures used in stress—corrosion tests have important effects on the associated stress intensities. This study examines those effects and uses finite element calculations to generate curves of stress intensity as a function of flaw size for several specimen types in common use. By means of a procedure based on compliance, the resulting data are recombined into a form suitable for crack-growth studies. A reliable method that uses these results is suggested here for measuring flaw size during long-term tests. A testing method of considerable versatility based on commonly used fracture specimens is discussed, and experimental experience with the method is described.

1084 Diffusion of oxygen in beta-Zircaloy and the high temperature Zircaloy-steam reaction. Pawel, R.E. (Oak Ridge National Lab., TN); Perkins, R.A.; McKee, R.A.; Cathcart, J.V.; Yurek, G.J.; Druschel, R.E. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* No. 633, 119-133(1977).

The diffusivity of oxygen in beta-Zircaloy-4 and the isothermal oxidation rates of Zircaloy-4 in steam were determined. Both sets of measurements were made in the temperature range 900 to 1500°C (1652 to 2732°F), and considerable care was exercised to ensure the accurady of temperature determinations. Diffusivity determinations were made using an ^{18}O radioactivation technique; supplemental measurements were made by Auger electron spectroscopy and by observations of the movement of $(\alpha + \beta)/\beta$ boundaries during diffusion anneals. No differences were observed between tracer and chemical diffusivity values or among oxygen diffusivities determined in zirconium, Zircaloy-2, and Zircaloy-4. Between 1000 and 1500°C (1832 and 2732°F) the combined data set for the diffusion of ^{16}O (corrected for mass effects from the ^{18}O data) was represented by: D/sub β/ = 0.0263 exp(-28200/RT) cm^2/s. Oxidation rate curves were determined at 50°C (90°F) intervals, ten specimens being used to define the curve at each temperature. Above 1000°C (1832°F) parabolic oxidation behavior was observed; below that temperature, the curves for the rate of growth of the oxide layer were not parabolic. For this reason, statistical evaluation of the data based on parabolic kinetics was limited to temperatures above 1000°C except for alpha-layer growth, which followed parabolic kinetics over the entire temperature range. The rate constants were well represented between 1000 and 1500°C by Arrhenius relationships.

1085 (NP-tr—2027) **Behavior of boron in X 10 CrNiMoTi 15 15 steel (Material No. 1.4970) in the case of heat treatment in various media.** Schneider, H. Translated from *J. Nucl. Mater.;* 49: 113-116(1974). 6p. British Library Lending Div., Yorkshire, Eng.

The behavior of various types of steel when used in liquid sodium has been investigated in the context of investigations into the corrosion of canning materials for the SNR300. Among the steels examined, there was a steel doped with boron. A test in sodium at 700°C for 5,000 hours showed that the boron content of this steel had dropped from about 80 ppM to less than 10 ppM. The object of the exercise was to determine the behavior of the boron content in the steel X10CrNiMoTi 15 15 after heat treatment in various media. (GHT)

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 641, 645, 724, 725, 1021, 1023

1086 (CONF-780722—9) **Tensile properties of neutron-irradiated 6061 aluminum alloy in annealed and precipitation-hardened conditions.** Farrell, K.; King, R.T. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

From 9. symposium on effects of radiation in structural materials; Richland, WA, USA (10 Jul 1978).

Tensile specimens of 6061 aluminum alloy (nominally 1 wt percent Mg, 0.6 Si) were heat treated to give fully annealed ("0" temper) and precipitation-hardened ("T6" temper) conditions and were irradiated in water at 328°K (0.35 T/sub m/) to fast (greater than 0.1 MeV) fluences up to 1.8 x 10^{27} n/m^2 and thermal (less than 0.025 eV) fluences up to 3.0 x 10^{27} n/m^2. The corresponding maximum displacement level was 260 dpa, and over 7 wt percent Si was created from transmutation reactions. The major microstructural defects were voids, dislocations and a precipitate of silicon. Swelling from voids was less than 1 percent. In the "T6" material tested at 323°K (0.35 T/sub m/) and 373°K (0.4 T/sub m/) irradiation raised the 0.2 percent flow stress and the UTS by 45 to 60 percent from the unirradiated values of about 280 and 330 MPa, respectively; ductility was reduced from 15 to about 9 percent. At 423°K (0.45 T/sub m/) there was a similar degree of hardening, but ductility fell to about 5 percent. The alloy in the "0" condition was softer, by 125 to 150 MPa, than the irradiated "T6" alloy, and its elongation remained above 10 percent. In all cases the loss in ductility occurred principally through reduction in uniform strain. Fractures were ductile.

1087 (CONF-780722—10) **Microstructure and tensile properties of heavily irradiated 1100-0 aluminum.** Farrell, K.; Richt, A.E. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

From 9. symposium on effects of radiation in structural materials; Richland, WA, USA (10 Jul 1978).

Microstructural changes and the resulting tensile properties of commercial purity (1100 grade) aluminum were measured after neutron irradiations up to 1.4 x 10^{27} n/m^2 (E greater than 0.1 MeV) and 2.3 x 10^{27} n/m^2 (E less than 0.025 eV) at approximately 328°K (0.35 T/sub m/) corresponding to displacement levels of 200 dpa and the generation of 5.5 wt percent Si. The material displayed up to about 8 percent swelling. Microstructural features included dislocation tangles, a precipitate of elemental silicon, and heterogeneously distributed voids coated with silicon. Alongside grain boundaries were sheets of large voids. These microstructural features are shown to be responsible for increasing the 0.2 percent flow stress and the UTS at 323°K by factors of 5 and 3 to values of 220 and 250 MPa, respectively, and by factors of 6.5 and 3.5 to about 190 MPa at 423°K (0.45 T/sub m/). Elongation was reduced at 323°K from 32 percent to a plateau at 12 percent in the fluence range 4 x 10^{25} n/m^2 to 7 x 10^{26} n/m^2 (greater than 0.1 MeV), followed by a sharp fall to 4 percent at the highest fluences, the latter concomitant with a change to intergranular-type fracture. In the 423°K tests the elongation declined from 56 percent to 4 percent at the highest fluences where intergranular-type fracture prevailed. Most of this loss in ductility is accountable in terms of dispersion hardening through changes in strain hardening parameters. It is suggested that the apparent intergranular fractures are caused by tearing of sheets of voids adjacent to grain boundaries.

1088 (CONF-7605178—1) **Redistribution of ion implanted boron induced by pulsed laser annealing.** White, C.W.; Christie, W.H.; Eby, R.E.; Wang, J.C.; Young, R.T.; Clark, G.J.; Wood, R.F. (Oak Ridge National Lab., TN (USA)). 1976. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From Conference on characterization techniques for semiconductor materials and devices; Seattle, WA, USA (21 May 1976).

Secondary ion mass spectrometry has been used to study changes in the profile of ^{11}B implanted into silicon and subsequently laser annealed using the Q-switched output of a ruby laser. Redistribution of the as-implanted profile is found to be pulse energy density and pulse number dependent. Calculation of the temperature profile shows that the surface region can be melted by the laser pulse, and theoretical profiles obtained by letting the as-implanted boron diffuse in liquid silicon are in good agreement with experimental results.

1089 (ORNL/TM—6359) **Effects of minor alloying additions on the strength and swelling behavior of an austenitic stainless steel.** Gessel, G.R. (Oak Ridge National Lab., TN (USA)). Jun 1978. Contract W-7405-ENG-26. 214p. Dep. NTIS, PC A10/MF A01.

Thesis. Submitted to Iowa State Univ.

A set of 32 alloys consisting of various additions of the elements Mo, W, Al, Ti, Nb, C and Si to an Fe-7.5 Cr-20 Ni alloy were made in order to investigate the effects of these solute additions on alloy swelling and strength. Both single and multiple additions were examined. The influence of various solute elements on the swelling behavior in the range 500 to 730°C was investigated using 4 MeV Ni ion bombardment to a dose 170 dpa. It was found that on an atomic percent basis, the elements may be arranged in order of decreasing effectiveness in reducing peak temperature swelling as follows: Ti, C, Nb, Si, and Mo. Small amounts of aluminum enhance swelling. Additions of Si, Ti, or Nb truncate the high temperature swelling regime of the ternary alloy. Mo, W, and C do not have a strong effect on the temperature dependence of swelling. The results may be interpreted in terms of the effect of point defect trapping on void growth rates, and it is suggested that the changes in peak temperature are the result of small changes in the free vacancy formation energy. A method for treating certain multiple additions is proposed. The effect of these alloying additions on short time high

temperature strength properties was estimated using hot hardness measurements over the temperature range 22 to 850°C. On an atom percent basis Nb and Ti were most effective in conferring solid solution strengthening and Si the least effective. In the regime 22 to approximately 650°C, the hardness data was found to fit an equation of the form: $H = H_0 + b/T$; where H is the hardness, T is the temperature, and H_0 and b are constants for a given alloy. An empirical method was devised to estimate the hot hardness of alloys containing more than one solute addition.

1090 (ORNL/TM—6443) **Irradiation creep by climb-enabled glide of dislocations resulting from preferred absorption of point defects.** Mansur, L.K. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

A mechanism of irradiation creep is proposed that arises from the climb-enabled glide of dislocations due to stress-induced preferred absorption of radiation-produced point defects. This creep component we term preferred absorption glide, PAG. PAG-creep operates in addition to the previously studied components of creep from climb by stress-induced preferred absorption, PA-creep, and the climb-enabled glide due to excess absorption of interstitials on dislocations during swelling, l-creep. A formulation of the various climb and climb-enabled glide processes is presented which includes earlier results. PAG-creep is comparable in magnitude to PA-creep in the parameter range of applications. While the PA-creep rate and the l-creep rate are linear in stress, the PAG creep rate is quadratic stress and thus dominates at high stress.

1091 **Growth kinetics and preference factor of Frank loops in nickel during electron irradiation.** Yoo, M.H.; Stiegler, J.O. (Oak Ridge National Lab., TN). *Philos. Mag.;* **36**: No. 6, 1305-1315(1977).

The growth kinetics of interstitial-type Frank loops in a thin foil of high purity Ni at 450°C has been measured during electron irradiation in a HVEM operating at 650 kV. The depth positions of the loops with respect to the foil surfaces were determined by stereomicroscopy. The experimental data were analyzed by use of the general rate-theory model which takes into account both temporal and spatial dependence of loop growth. It is found from systematic variations of the vacancy migration energy, E/sub v/m, and the preference factor of dislocation loops for self-interstitials, delta/sub i/, that E/sub v/m = 1.2 eV and delta/sub i/ = 0.06, which together yield reasonable agreement between the theoretical model and the experimental data.

1092 **Ni_3Si surface-film formation caused by radiation-induced segregation.** Potter, D.I.; Rehn, L.E.; Okamoto, P.R.; Wiedersich, H. (Argonne National Lab., IL). *Scr. Metall.;* **11**: No. 12, 1095-1099(1977).

A substantial Ni_3Si film is shown to form on the surface of irradiated specimens of NiSi solid solution as well as two-phase Ni-Si alloys. (GHT)

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 21, 26, 983, 1223

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 986, 987

1093 (AD-A—051502) **(Long range materials research) development of elevated-temperature electrocrystallization techniques. Final report, 1 June 1975—31 December 1977.** Huggins, R.A.; Elwell, D.; Feigelson, R.S.; De Mattei, R.C. (Stanford Univ., CA (USA). Center for Materials Research). Feb 1978. Contract N00014-75-C-1171. 53p. (CMR—78-4). NTIS PC A04/MF A01.

The aim of this program was to develop the techniques and understanding necessary for the growth of films or single crystals of a variety of materials by molten salt electrocrystallization. The conditions for stable growth of materials by this technique have been explored both theoretically and experimentally. The theoretical studies have shown the importance of a high solute concentration, the potential gradient at the crystal-solution interface and a material parameter which we have termed the growth rate constant. The current density, which determines the rate of deposition, is also a crucial parameter in many experiments, and a value in the range 10-50 mA/cm² must not be exceeded if stable growth is to occur.

1094 (SAND—78-0404C) **Hydrogen concentration profiles and chemical bonding in silicon nitride.** Peercy, P.S.; Stein, H.J.; Doyle, B.L.; Picraux, S.T. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 22p. (CONF-780686—1). Dep. NTIS, PC A02/MF A01.

From 20. electronic materials conference; Santa Barbara, CA, USA (28 Jun 1978).

The complementary technique of nuclear reaction analysis and infrared absorption were used to study the concentration profile and chemical bonding of hydrogen in silicon nitride for different preparation and annealing conditions. Silicon nitride prepared by chemical vapor deposition from ammonia-silane mixtures is shown to have hydrogen concentrations of 8.1 and 6.5 at.% for deposition temperatures of 750 and 900°C, respectively. Plasma deposition at 300°C from these gases results in hydrogen concentrations of approximately 22 at.%. Comparison of nuclear reaction analysis and infrared absorption measurements after isothermal annealing shows that all of the hydrogen retained in the films remains bonded to either silicon or nitrogen and that hydrogen release from the material on annealing is governed by various trap energies involving at least two N-H and one Si-H trap. Reasonable estimates of the hydrogen release rates can be made from the effective diffusion coefficient obtained from measurements of hydrogen migration in hydrogen implanted and annealed films.

1095 (UCRL-Trans—11389) **Refractory composite.** Karpinos, D.M.; Grosheva, V.M.; Pilipovskii, Yu.L.; Shamatov, Yu.M.; Golenevich, V.A.; Kravchenko, A.A.; Gordienko, A.I.; Orlova, G.P. Jun 1978. Translation of USSR Patent 484204, 1975. 3p. Dep. NTIS, PC A02/MF A01.

An invention is described which increases the compressive strength of aluminum nitride and filamentary mullite single crystals by the addition of carbon fibers. The mixture is hot pressed at 1750°C and 150 kg/cm². (GHT)

1096 **Technique for preparing highly-sinterable oxide powders.** Dole, S.L.; Scheidecker, R.W.; Shiers, L.E.; Berard, M.F.; Hunter, O. Jr. (Ames Lab., IA). *Mater. Sci. Eng.;* **32**: 277-281(1978).

A technique for preparing highly sinterable rare-earth, hafnium, and zirconium oxide powders has been developed. Acetone and toluene are used to strip the water off precipitated hydroxide gels to give a uniform and rapidly drying powder. After calcination and firing, these powders yield nearly theoretically dense specimens. A characterization of these powders was performed and related to processing variables.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 986, 999, 1107

1097 **Investigation of the influence of the isotopic effect on the metal—insulator phase-transition temperature in vanadium oxides.** Wolf, E.; Oppermann, G.; Reichelt, W.; Terukov, E.I. (A. F. Ioffe Physicotechnical Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 3, 147-149(5 Feb 1978).

We investigated the influence of the isotopic effect on the metal—insulator phase-transition temperature in vanadium oxides for the purpose of determining the contribution of the phonon subsystem to the mechanism of phase transitions of this type. It is shown that a regular feature of all the investigated vanadium oxides is a shift of the phase-transition temperature towards higher temperatures when the oxygen O^{16} is replaced by its isotope O^{18}.

1098 **Electronic structure of $SrTiO_3$ and some simple related oxides (MgO, Al_2O_3, SrO, TiO_2).** Kowalczyk, S.P.; McFeely, F.R.; Ley, L.; Gritsyna, V.T.; Shirley, D.A. (Lawrence Berkeley Lab., CA). *Solid State Commun.;* **23**: 161-169(1977).

The valence band density of states (VBDOS) of the insulating oxides $SrTiO_3$, TiO_2, SrO, MgO and Al_2O_3 obtained by x-ray photoelectron spectroscopy (XPS) are reported. Qualitatively, the VBDOS of these oxides are similar to one another. The XPS results are compared with results from soft x-ray emission spectroscopy (XES), ultraviolet photoemission spectroscopy (UPS), and theoretical calculations. There are some differences (in particular for TiO_2) between the XES and XPS results, which are probably due to matrix element effects enhancing different features of the VBDOS in the two techniques. The XPS results definitively establish the position of the O 2s level, which had been erroneously assigned in previous low-energy UPS measurements. Cluster-type calculations are demonstrated to give a reasonable representation of the VBDOS for the oxides.

1099 **Structural phase transition in the spinel $MgAl_2O_4$.** Mishra, R.K.; Thomas, G. (Lawrence Berkeley Lab., CA). *Acta Crystallogr., Sect. A;* **A33**: 678-679(1977).

A new crystallographic phase transformation in $MgAl_2O_4$ is reported in which the low-temperature low-symmetry space group of $MgAl_2O_4$ transforms to the "spinel" space group Fd3m at approximately 450°C. The in situ electron diffraction experiments suggest that this is a second-order phase transformation.

1100 **Plastic deformation of ceramic materials.** Dokko, P.C.; Pask, J.A. (Univ. of California, Berkeley). *Mater. Sci. Eng.;* **25**: 77-86(1976).

The complexity of the characters of ceramic materials enhances difficulties of evaluating the effect of various parameters on the plastic behavior of the materials. Grain- and grain-boundary processes contribute to plastic strain. The factors of greatest uncertainty are the nature and effect of the grain boundaries and adjoining regions, and of the pores. Equally important is the need of a science of ceramic processing so that specimens with designed characters (microstructures) can be fabricated for controlled mechanical-behavior studies.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 1032, 1095

1101 Creep mapping in a polycrystalline ceramic: application to magnesium oxide and magnesiowustite. Hodge, J.D.; Lessing, P.A.; Gordon, R.S. (Univ. of Utah, Salt Lake City). *J. Mater. Sci.;* **12**: 1598-1604(1977).

The construction of deformation mechanism maps for a polycrystalline ionic solid in which anion and cation transport are coupled has been demonstrated. Because of anion—cation ambipolar coupling, two regimes of Coble creep are possible in systems where anion grain boundary transport is rapid: (1) rate-controlled at low temperatures and small grain sizes by cation grain-boundary diffusion, and (2) rate-limited at high temperatures and large grain sizes by anion grain-boundary diffusion. A new type of deformation mechanism map was introduced in which the temperature and grain size were primary variables. This map was shown to be particularly useful for materials which deform primarily by diffusional creep mechanisms. Ambipolar diffusional creep theory was used to construct several deformation mechanism maps for polycrystalline MgO and magnesiowustite over wide ranges of stress, grain size, temperature and composition.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 4, 784, 1035, 1039, 1054, 1094

1102 Nonequilibrium states in an illuminated Sn—SnO/sub x/—Pb superconducting tunnel structure. Gerbshtein, Y.M.; Nikulin, E.I.; Spivak, B.Z. (A. F. Ioffe Physicotechnical Institute, Acaemy of Sciences of the USSR, Leningrad). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 4, 616-618(Apr 1978).

An investigation was made of the influence of illumination on the current-voltage characteristics of Sn—SnO/sub x/—Pb tunnel structures. Illumination of the Sn film did not alter the equilibrium distribution function of the excess quasiparticles. The results obtained by illumination of the Pb film were attributed to a temperature difference between the electron subsystems of Pb and Sn and to a finite chemical potential of the distribution function of the quasiparticles in Pb.

1103 Magnetic properties of scandium hydrides. Volkenshtein, N.V.; Galoshina, E.V.; Mishchenko, A.P.; Shubina, T.S. (Institute of Metal Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 250-253(5 Mar 1978).

The first investigation of the magnetic susceptibility of scandium hydrides is reported. The behavior of the magnetic properties in the single-phase region is explained using a proton model.

1104 Dielectric-metal phase transition in V_2O_3. Terukov, E.I.; Khomskii, D.I.; Chudnovskii, F.A. (A. F. Ioffe Physico-technical Institute, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1160-1167(Dec 1977).

Results are presented of a comprehensive investigation of a phase transition in V_2O_3, which is identified on their basis as dielectric—metal phase transition (DMPT). The entire investigated aggregate of properties (kinetic, magnetic, optical, structural) is interpreted is best fashion within the framework of a model with strong electron—electron correlations of the Mott-Hubbard type in both the low- and the high-temperature phases. Above the phase-transition temperature, V_2O_3 is a poor metal with a strong degree of disorder, a small mean free path, and localized magnetic moments. The DMPT that takes place at 430 K is apparently connected with differentiation of the charge and with the spatial localization of the vanadium ions with different valences.

1105 Moessbauer effects with ^{137}La. Gerdau, E.; Winkler, H.; Sabathil, F. (Univ., Hamburg). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 35-38(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Moessbauer effect with a radioactive absorber of 6 . 10^4y ^{137}La was observed. Spectra for the system CeO_2-$LaCrO_3$ and CeO_2-La_2O_3 have been fitted and yielded values for the quadrupole interactions and the ratio of the quadrupole moments of the ground and excited state.

1106 Effect of carbon and water on wetting and reactions of B_2O_3-containing glasses on platinum. Holmquist, G.A.; Pask, J.A. (Univ. of California, Berkeley). *J. Am. Ceram. Soc.;* **59**: No. 9-10, 384-386(1976).

Sessile-drop experiments were conducted to analyze the wetting characteristics of molten B_2O_3 and B_2O_3-containing glasses on Pt. In atmospheres free of carbonaceous gases, the contact angle for all glasses on Pt was small and invariant under ambient pressures of 10^{-4} torr to 1 atm for the range 700° to 1000°C. Adsorption of carbon at the metal surface decreased the solid/vapor surface energy and increased the contact angle. Carbon was removed by oxidation at a specific ambient pressure, resulting in a reduction in the contact angle. Temperature-pressure data are reported for Pt. Absorption of water vapor by the glasses resulted in a reaction at the solid/liquid interface, spreading of the glass, and adherence. The possible reactions that can occur are given.

RADIATION EFFECTS

1107 (ORO—4837-5) **Electronic structure of defects in oxides.** (Oklahoma State Univ., Stillwater (USA)). 1978. Contract EY-76-S-05-4837. 15p. Dep. NTIS, PC A02/MF A01.

Single crystal samples of α-Al_2O_3 have been studied which were colored during growth. The samples initially contained a single absorption band at 6.1 eV with a half-width of 0.68 eV. The sample had to be heated to over 1400°C to remove this band. The 6.1 eV band could be optically bleached at 10°K, which introduced bands at 4.1 eV, 4.8 eV and 5.4 eV, and which shifted the high energy peak to 6.05 eV. Bleaching the 6.1 eV band (at 10°K also) produced photoconductivity and an emission band at 3.0 eV, with a half-life of about 10 ms. The spectral dependence of the photoresponse and the excitation spectrum of the 3.0 eV band were similar to the 6.1 eV absorption. After bleaching an emission band at 3.8 eV was produced, which was similar to a band produced in particle irradiated material. The lifetime of the 3.8 eV emission was less than 50 ns, and the excitation spectrum contained peaks at 4.8 eV and 5.4 eV with a small shoulder at 5.9 eV. The temperature dependence of the half-width of the 3.8 eV emission followed a hyperbolic cotangent relation with an effective frequency of 340 +- 20 cm^{-1}. An absorption band at 5.2 eV can be introduced into $MgAl_2O_4$ by incident electrons or neutrons. The threshold energy for the electron process is 0.325 MeV. The defect responsible for the 5.2 eV band in electron irradiated spinel anneals out at 250°C. The 5.2 eV band can be optically bleached at 40°K. Edge luminescence at 5.02 eV has been produced in SrO using electron or ultraviolet light excitation. The excitation spectrum of the emission has a threshold at 5.3 eV which is the same as for the production of free charge.

COMPOSITE MATERIALS

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 1017

1108 (UCID—17755(Pt.2)) **Stress-rupture life of Kevlar/epoxy spherical pressure vessels.** Toland, R.H.; Chiao, T.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Jun 1978. Contract W-7405-ENG-48. 79p. Dep. NTIS, PC A05/MF A01.

A study is in progress to determine the life of Kevlar/epoxy spherical pressure vessels subjected to a constant, sustained pressure until vessel failure, i.e., stress-rupture. This study has two objectives: to generate baseline data on the stress-rupture life of Kevlar/epoxy pressure vessel and to apply statistical reliability theory to vessel and strand data to define vessel life statistics and reliability at given pressure (stress) levels. This report, the second of three, is a compilation of the current pressure vessel data to-date and all strand stress-rupture data generated at Lawrence Livermore Laboratory on several composite materials.

1109 Measurement of shear properties of fibre composites. Part II. Shear properties of an aramid fibre in several epoxy resins. Chiao, C.C. (Lawrence Livermore Lab., CA); Moore, R.L.; Chiao, T.T. *Composites;* 171-174(Jul 1977).

Shear properties of composites consisting of an aramid fibre (Kevlar 49) impregnated with seven different epoxy resins were measured with the +-45° off-axis laminate tensile shear test. Experimental results showed that the shear properties of composites made from this fibre varied depending on the epoxy resin used, and that this shear test successfully detected those variations: the shear modulus, failure stress, and shear strain at failure stress varied from 1520 to 1923 MPa, 21.4 to 39.7 MPa, and 1.35 to 2.43%, respectively.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 1017

POLYMERS AND PLASTICS

1110 (JPRS—71136, pp 6-14) **Effect of energy of superhigh-frequency electromagnetic fields on the bodies of experimental animals under different conditions of ultraviolet irradiation.** Gabovich, R.D.; Shutenko, O.I. (Medical Inst., Kiev). 18 May 1978. Translated from Gig. Tr. Prof. Zabol.; No. 9, 31-37(1977).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

A 4-month daily (3-hour) effect of superhigh-frequency energy with a power flux density of 100 and 1,000 $\mu W/cm^2$ produced in experimental rats kept under conditions of ultraviolet deficit (20 to 25μ/$\mu Oe/cm^2$ per day) unfavorable changes on the part of the studied physiological, biochemical, and immunobiological indicators of the state of the body. Judging from almost all the indicators, including integral, irradiation of animals with ultraviolet rays in a dose of 400 $\mu Oe/cm^2$ per day increased the tolerance of animals for the effect of superhigh-frequency energy with a power flux density at a level of 100 $\mu W/cm^2$.When the power flux density is 1,000 $\mu W/cm^2$, the positive effect of ultraviolet irradiation is reflected to a lesser extent. The effect of the superhigh-frequency field against the background of excess ultraviolet irradiation approximates its effect with ultraviolet deficit.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 984

STRUCTURE AND PHASE STUDIES

1111 **Rayleigh scattering of Moessbauer radiation from plastic crystals.** Champeney, D.C. (Univ. of East Anglia, Norwich, Eng.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 112-113(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

A survey is given of some results on the Rayleigh scattering of Moessbauer radiation from plastic crystals in polycrystalline form. In each case the elastic component in the scattered radiation shows a more or less abrupt decrease in value on warming through each phase transition at which molecular motion increases. The possibility of obtaining detailed information on the nature of molecular rotation in the plastic crystal phase is discussed.

OTHER MATERIALS

1112 (SAND—78-0833C) **Identification and elimination of organic contaminants on the surface of PLZT ceramic wafers.** Wagner, J.A. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 17p. (CONF-780907—2). Dep. NTIS, PC A02/MF A01.

From 4. conference on contamination; Washington, DC, USA (10 Sep 1978).

Surface contamination of PLZT (lead lanthanum zirconate-titanate) hot-pressed ferroelectric ceramics being used as the electrooptic wafers in thermal/flash protective goggles has caused "mottling" on the surface of the wafers adversely affecting the performance of the goggles. Mottling describes the nonuniform appearance of the goggle lens in the transmitting (open) and protective (closed) states. Experiments were devised to identify the contaminant and to find a method of effectively removing it from the ceramic surface without changing the electrical properties of the PLZT. Infrared spectroscopy, secondary ion mass spectroscopy, Auger electron spectroscopy and scanning electron microscopy were used to determine the type and extent of contamination and effectiveness of cleaning methods. The contaminant was identified as the residue from an optical adhesive used in processing the wafers. Various cleaning methods were compared: washing and soaking wafers in a 50 percent potassium carbonate/deionized water solution; solvent cleaning with various combinations of tetrahydrofuran, methylene chloride, methylethylketone; oxygen plasma; ultraviolet light. Results indicated that although solvents and potassium carbonate solutions removed the gross contamination there was still a sufficient amount present to cause the "mottling". In addition, some adverse effects on the ceramic surface were discovered in the case of K_2CO_3 cleaning. Auger scans proved ultraviolet light to be the most effective method with no contamination remaining after a two hour exposure and no apparent surface damage. A model explaining the behavior of the contaminated surface with respect to various solvents was developed.

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 416, 418, 419, 430

1113 (SAND—78-7059) **rf-sputtered tetragonal barium titanate films on silicon.** Panitz, J.K.G.; Hu, C.C. (Sandia Labs., Albuquerque, NM (USA); New Mexico Univ., Albuquerque (USA)). Aug 1978. Contract EY-76-C-04-0789. 25p. Dep. NTIS, PC A02/MF A01.

Tetragonal crystals of $BaTiO_3$ with ferroelectric properties are regularly observed for $BaTiO_3$ films thicker than 1000 A rf sputter deposited at 5 A/min onto silicon substrates at temperatures above 500°C. There is a severe interaction problem between the silicon substrate and the $BaTiO_3$ that contaminates the film, which can be avoided by growing a pacification layer of SiO_2 on the silicon substrate before depositing $BaTiO_3$. Despite a coefficient of thermal expansion mismatch between $BaTiO_3$ and silicon, thin films with good electrical insulation properties can be obtained when the substrate temperature exceeds 300°C by reducing the substrate temperature during the deposition by 6.5 to 7.0°C/min to a final substrate temperature of 200°C.

1114 **Explosive fabrication of rapidly quenched materials.** Cline, C.F.; Hopper, R.W. (Univ. of California, Livermore). *Scr. Metall.;* **11**: No. 12, 1137-1138(1977).

Research into methods for explosive fabrication of alloy glasses—one class of rapidly quenched materials—is described. Recent developments have resulted in two major breakthroughs for the processing of metallic alloy glasses. The first was the successful demonstration that a $Ni_{40}Fe_{40}B_{20}$ alloy glass ribbon can be explosively welded or cladded to A516-70 steel. To accomplish this, the alloy glass ribbon was driven downward onto the steel by a powdered explosive. The welded ribbon was bonded tightly to the steel. Large-angle x-ray scans revealed that the welded ribbon still was amorphous. A second series of tests demonstrated that the alloy glass ribbon could be explosively welded to a second ribbon, suggesting that three-dimensional structures can be fabricated from a stack of alloy glass ribbons. (GHT)

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 1913

1115 (BNL—24554) **Fluctuations and freezing in a one-dimensional liquid: Hg/sub 3-δAsF₆.** Axe, J.D. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 12p. (CONF-780685—1). Dep. NTIS, PC A02/MF A01.

From Symposium on nonlinear structure and dynamics in condensed matter; Oxford, UK (27 Jun 1978).

This talk is devoted to a discussion of a simple model developed and analyzed by EMERY and AXE for Hg/sub 3-delta/AsF_6 (although with little modification it should be useful in thinking about other linear incommensurate phases as well). It incorporates competing parallel and perpendicular chain interactions, predicts correctly the long range order and clarifies the apparent failure of the system to anticipate this ordering in the fluctuations above T/sub c/. In addition, it treats carefully the effects of one-dimensional fluctuations, and predicts that the Hg chains at high temperatures behave as a one-dimensional liquid. The subsequent phase transformation can be thought of as a freezing of the 1-d Hg liquid, and can be discussed in terms of self-consistent solutions of the sine-Gordon Hamiltonian.

1116 (LA-UR—78-1865) **Properties of metallic glasses containing actinide metals. I. Thermal properties of U—M glasses (M = V, Cr, Mn, Fe, Co, and Ni).** Giessen, B.C.; Elliott, R.O. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 9p. (CONF-780726—1). Dep. NTIS, PC A02/MF A01.

From 3. conference on rapid quenching; Brighton, UK (3 Jul 1978).

The results of a preparative and calorimetric study forming part of a continuing investigation of the new actinide glasses are reported. Specifically, lower bounds for the composition limits of glass formation (G.F.) at moderate cooling rates have been obtained for the U-M (M = Mn, Fe, Co, Ni) systems and the thermal stabilities of glasses in these four systems as well as for a U-V glass and a U-Cr glass have been surveyed.

1117 (SAND—78-0499C) **Effect of paramagnetic impurities on NMR in superionic conductors.** Follstaedt, D.M.; Richards, P.M. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 1p. (CONF-780836—1). Dep. NTIS, PC A02/MF A01.

From 20. congress ampere; Tallinn, USSR (21 Aug 1978).

Relaxation of mobile ^7Li nuclei in $LiAlSiO_4$ and other Li^+ conductors is shown by the high temperature $T_1 : T_2$ ratio to be caused by paramagnetic impurities. The stationary ^{27}Al, however, is relaxed by quadrupole coupling.

1118 (SAND—78-0751C) **Effect of pressure on the crystal field splitting in rare earth pnictides and chalcogenides.** Schirber, J.E.; Weaver, H.T. (Sandia Labs., Albuquerque, NM (USA)). 1978. Con-

tract EY-76-C-04-0789. 7p. (CONF-780913—2). Dep. NTIS, MF A01.

From Colloque of physics of the metallic rare earths; St. Pierre De Chartreuse, France (4 Sep 1978).

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The experimental situation for the pressure dependence of the crystal field of praseodymium pnictides and chalcogenides is reviewed and compared with the predictions of the point charge model. The problem of separating exchange and crystal field contributions from the measured NMR frequency shift or susceptibility measurements is discussed as well as problems explaining these effects with conduction electron related models.

1119 Structure of hydrogen center in D-implanted Si. Picraux, S.T.; Vook, F.L. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev., B;* **18**: No. 5, 2066-2077(1 Sep 1978).

Ion-implantation and ion-channeling measurements have been used to study deuterium (D) in silicon. The D was introduced at room temperature by implantation to 13 keV into single-crystal Si. The D was detected and its depth profile was measured by the D(^{3}He, p)^{4}He nuclear reaction, and simultaneously the Si lattice signal was obtained from the ^{3}He backscattering. Comparisons of the observed channeling angular distributions with continuum-model calculated distributions for the <111>, <110>, and <100> axial and {110} planar channeling directions indicate that the D is located predominantly in a single interstitial site 1.6 A along a <111> direction from a Si atom in the antibonding direction. The resulting structure is compared to other known impurity interstitial centers in Si and implications of this site are discussed.

1120 Single-crystal neutron-diffraction study of AgI between 23° and 300°C. Cava, R.J. (Massachusetts Inst. of Tech., Cambridge); Reidinger, F.; Wuensch, B.J. *Solid State Commun.;* **24**: 411-416(1977).

Least-squares refinements and partial Fourier syntheses at several temperatures indicate that the silver density in the high-temperature α-form consists of a tetrahedrally coordinated equilibrium position ($^1/_4 0 ^1/_2$) and a three-coordinated saddle point (0.39 0.39 0). This complex silver distribution may be completely accounted for by higher-order thermal tensors. The final R values range from 0.9 to 2.3%.

1121 Model transition metal—carbene system $MnCh_2$. Brooks, B.R.; Schaefer, H.F. III. (Lawrence Berkeley Lab., CA). *Mol. Phys.;* **34**: No. 1, 193-213(1977).

The first transition metal—methylene species, $Ta(C_5H_5)_2$ CH_3CH_2, has recently been prepared and characterized by Schrock and co-workers. As a model for systems of this type, ab initio electronic structure theory has been applied to the $MnCH_2$ molecule. After experimentation with several types of basis sets, the following double-zeta contracted gaussian basis was adopted: Mn(12s 8p 4d/8s 6p 2d), C(9s 5p/4s 2p), H(4s/2s). However, in some cases it was found necessary to add a set of more diffuse d functions to the above. Single-configuration self-consistent-field (SCF) potential curves are reported for electronic states dissociating to Mn^+ ($4s\ 3d^5$ ^{7}S), Mn($4s^2\ 3d^5\ ^6$S), Mn($4s\ 3d^6\ ^6$D) and Mn($4s\ 4p\ 3d^5\ ^6$P) plus $^3B_1$ CH_2 and $^1A_1$ CH_2. The electronic ground state of $MnCH_2$ is of $^8B_1$ symmetry and for this state only a full geometry optimization was performed, yielding r/sub e/(Mn—C) = 2.16 A, theta/sub e/(HCH) = 109°, and r/sub e/(C—H) = 1.09 A. In the SCF approximation $^8B_1$ $MnCH_2$ is bound by 33 kcal/mole relative to infinitely separated ^{6}S Mn + $^3B_1$ CH_2. The predicted dipole moment is +1.48 compared to those of isolated triplet and singlet methylene, -0.66 and -2.40 debye. The second low-lying strongly bound state is of $^8A_1$ symmetry, arising from ^{6}D Mn + $^3B_1$ CH_2. The predicted equilibrium geometry is r/sub e/(Mn—C) = 2.18 A, theta/sub e/(HCH) = 142°, corresponding to a dissociation energy of 39 kcal. Several higher electronic states dissociating to singlet CH_2 are also predicted to be bound. The lowest bound state is of $^6B_1$ symmetry with r/sub e/(Mn—C) = 1.90 A, theta/sub e/(HCH) = 108°, corresponding to a dissociation energy of 38 kcal/mole.

PROPERTIES

REFER ALSO TO CITATION(S) 418, 464, 465, 536, 1069, 1105, 1117

1122 (MHSMP—78-23) **Substitute potting compound for Sylgard 93-119 based on Sylgard 184 and Q3-6527 dielectric gel.** Flowers, G.L.; Switzer, S.T. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Jun 1978. Contract EY-76-C-04-0487. 12p. Dep. NTIS, PC A02/MF A01.

Development of a substitute potting compound developed by Pantex to replace the no longer available Dow Corning 93-119 is described. The specific approach taken in this development utilized Dow Corning Sylgard 184 as the basic starting material, altering its viscosity with Dow Corning Dielectric Gel Q3-6527 and then modifying the cure rate with Dow Corning Accelerator Q3-6559. Various tests were run to characterize both chemical and physical properties of the substitutes as well as the initial 93-119 and the starting raw materials. Summaries of the data peculiar to this substitute are presented here whereas a more detailed examination of the test methods and results for the overall project are presented in another report. The properties of two substitutes developed from the two extremes of viscosity to be expected for Sylgard 184 during production are presented. These substitutes are easily quick-frozen in the catalyzed state for production use upon thawing. They are however somewhat more difficult to deaerate and eventually cure to a harder state than the original DC 93-119.

1123 (ORO—3861-24) **Electronic properties of liquids. Annual progress report, November 1, 1977—October 31, 1978.** Painter, L.R. (Tennessee Univ., Knoxville (USA). Dept. of Physics). 1978. Contract EY-76-S-05-3861. 37p. Dep. NTIS, PC A03/MF A01.

Refinement of the photoionization method for measuring the reflectances of liquids and the investigation of benzene as a filling gas in the ion chambers are described. The optical functions of glycerol were determined to 24.4 eV. The improved accuracy of this measurement of reflectance by gas ionization permitted a more accurate value of the plasmon energy (22 eV) than that previously reported. A second liquid formamide has been studied using this photoionization technique. Concomitant with photoionization studies, electrons from the photon bombarded liquids have been analyzed. This photoemission may provide additional information about electron energy levels in liquids. (GHT)

1124 (SAND—78-0602) **Large laser energy and power transmitted through optical fibers.** Landry, M.J. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 31p. Dep. NTIS, PC A03/MF A01.

The surface threshold damage level (STDL) and ratio of output-to-input energy (coupling efficiency, epsilon/sub c/) have been determined for fibers manufactured by American Optical Company (AOC), Corning Glass Works (CGW), and Incom Inc. (II) using Nd^{3+} giant laser pulses of approximately 30 ns duration. The largest STDL's were observed for the AOC fibers with values of 48.2 J/cm and 1.61 GW/cm^2 for single and 31.6 J/cm^2 and 1.05 GW/cm^2 for multiple laser shots. For multiple laser shots into one fiber the energy in each successive shot was increased. The AOC fibers also transmitted the maximum energy and power density for single and multiple laser shots. The STDL for the II fibers was approximately 6.8 times less than for the AOC fibers. The STDL for the CGW fibers was not reached due to the lower 8.9 J/cm^2 energy density available from the laser system during this phase of testing. For large input energy density (xi/sub in/) values the fibers receiving single laser shots exhibited the largest epsilon/sub c/ vs xi/sub in/ values before surface damage caused a reduction in epsilon/sub c/. Multiple laser shots caused surface damage at lower xi/sub in/ values which resulted in lower epsilon/sub c/ values for successive shots. The surface damage always originated in the bonding material used in holding the fibers together. In the multiple laser shot cases increased energy caused the initial damage sites to increase in size and caused the formation of new sites at lower STDL's with increasing radial dimension relative to the initial site. There is no evidence that the observed decrease in epsilon/sub c/ was caused by other than surface damage to the input end of the fibers.

1125 Core-level photoemission of the Cs-O adlayer of NEA GaAs cathodes. Spicer, W.E.; Lindau, I.; Su, C.Y.; Chye, P.W.; Pianetta, P. (Stanford Electronics Laboratories, Stanford University, Stanford, California 94305). *Appl. Phys. Lett.;* **33**: No. 11, 934-935(1 Dec 1978).

Negative-electron-affinity (NEA) photocathodes are made possible by adding Cs and oxygen to the surface of Si or GaAs and other III-V materials. In this work, the chemistry of the Cs-O adlayer on GaAs is studied by following the Cs, Ga, and As core-level shifts at h/sub ν/=120 eV. The changes in binding energy for the Cs core levels were studied as a function of oxygen exposure. Oxygen was found to bind to As of GaAs for exposures above 10 L. These results are discussed in terms of the importance of Cs suboxides, in relation to the interfacial barriers which limit the ultimate photothreshold of NEA cathodes.

1126 Chemisorption and oxidation studies of the (110) surfaces of GaAs, GaSb, and InP. Pianetta, P.; Lindau, I.; Garner, C.M.; Spicer, W.E. (Stanford Electronics Laboratories, Stanford University, Stanford, California 94305). *Phys. Rev., B;* **18**: No. 6, 2792-2806(15 Sep 1978).

The surface chemistry of cleaved GaAs(110) (and, to a lesser extent, InP and GaSb) is studied as a function of oxygen exposure (both unexcited and excited) with soft-x-ray photoemission spectroscopy. When the cleaved GaAs (110) surface is exposed to molecular oxygen in the ground state, chemisorption to only the arsenics takes place. No back bonds are broken even for large exposures. Room-temperature oxidation of the surface can be induced by exciting the

oxygen, e.g., by an ionization gauge. The adsorption of excited oxygen is initially the same as for the unexcited, except 500 times faster. However, after > 20% of a monolayer has been adsorbed, further exposure to excited oxygen causes back bonds to be broken and As_2O_3 and Ga_2O_3 are formed. Larger doses of excited oxygen result in the formation of thicker oxides composed primarily of Ga_2O_3 with small amounts of elemental As (or As bound to only one Ga) and As_2O_3, most of which has sublimed from the surface. No As_2O_5 is seen in the thicker oxide because there is a deficiency of oxygen, and any partially oxidized Ga present will reduce the arsenic oxides. The escape depth for GaAs(110) was measured for electron kinetic energies between 20 and 200 eV. This range includes the minimum in the escape depth which is about 6 A at 60 eV. No chemical shift in the core levels between the atoms on the surface and in the bulk was observed. GaSb (110) and InP (110) surfaces were also studied. InP behaves like GaAs, whereas the GaSb is oxidized immediately even when exposed to only unexcited oxygen. The oxygen uptake curves for GaSb and GaAs were compared and found to be quite different with a sticking coefficient, at zero coverage, of 2×10^{-4} for GaSb and 8×10^{-10} for GaAs.

1127 Phonon dispersion in intermediate-valence Sm/sub 0.75/ Y/sub 0.25/S. Mook, H.A.; Nicklow, R.M.; Penney, T.; Holtzberg, F.; Shafer, M.W. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **18**: No. 6, 2925-2928(15 Sep 1978).

Phonon dispersion has been measured in an intermediate-valence-state system. The phonons of intermediate valence Sm/sub 0.75/Y/sub 0.25/S are vastly different from those of the SmS and YS constituents. The LA phonons are unusually soft compared to the TA and have anomalous widths, particularly for the [111] direction. The LO phonons lie below the TO. Temperature-dependent measurements show that the anomalous phonon properties change with changing valence.

1128 Spin-wave excitations and low-temperature magnetization in the amorphous metallic ferromagnetic (Fe/sub x/Ni/sub 1-x/)$_{75}P_{16}B_6Al_3$. Birgeneau, R.J.; Tarvin, J.A.; Shirane, G.; Gyorgy, E.M.; Sherwood, R.C.; Chen, H.S.; Chien, C.L. (Department of Physics and Center for Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., B;* **18**: No. 5, 2192-2195(1 Sep 1978).

We have carried out a systematic study of the spin-wave dispersion relations and the low-temperature magnetization in the amorphous metallic ferromagnets (Fe/sub x/Ni/sub 1-x/)$_{75}P_{16}B_6Al_3$ for x = 1.0, 0.65, 0.5, and 0.30. In this series the Ni is, to a first approximation, nonmagnetic. The spin-wave measurements were carried out using inelastic-neutron-scattering techniques, the magnetization at finite fields (1.2 and 15 kOe) was measured via a vibrating-sample magnetometer and the temperature dependence of the magnetization at zero field was deduced from the hyperfine field at the Fe sites as measured by Moessbauer techniques. The spin waves follow a normal ferromagnetic dispersion relation, $h\omega(q) = \Delta + Dq^2 + Eq^4 + ...$, in all materials. The magnetization follows the law M (T) = M/sub o/(1 - BT/sup 3/2/ - ...). The T/sup 3/2/ coefficient B is nearly field independent for the samples with x = 1.0, 0.65, and 0.5. Further the Moessbauer and magnetometer measurements are in close quantitative agreement. We find that for these samples the observed B's are properly accounted for by the measured spin-wave dispersion relations in contrast to previous studies in other magnetic glasses. Anomalous effects are observed in the x = 0.30 sample.

1129 Experimental study of self-focusing in a liquid crystalline medium. Hanson, E.G. (Univ. of California, Berkeley); Shen, Y.R.; Wong, G.K.L. *Appl. Phys.;* **14**: 65-77(1977).

Self-focusing of light was studied in the liquid crystalline medium p-ethoxybenzyldine-p-butylaniline (EBBA). By variation of temperature, the response time of the field-induced refractive index was adjusted from larger than to smaller than the Q-switched laser pulsewidth. Accordingly, self-focusing varied from transient to quasi-steady-state. The results agree well with existing theoretical predictions and can be qualitatively understood from a simple physical description. The induced stimulated Brillouin scattering was also measured and was shown to be responsible for the limiting diameter of the self-focused beam in the present case.

1130 Calibration constants in Moessbauer diffraction experiments. Mullen, J.G.; Stevenson, J.R. (Purdue Univ., West Lafayette, IN). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 55-58(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

The ratio of the inelastic to total scattering for the (200) Bragg peak of LiF was measured to be (1.4 +- 1.0)%. This result is an order of magnitude less than reported by O'Connor and Butt, and it can be used as a basis for a simpler calibration of the elastic and inelastic components of scattering for other Moessbauer diffraction experiments.

1131 Selective excitation method. Hoy, G.R. (CEN, Grenoble, France). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 59-62(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Recently progress has been made in understanding the selective excitation and subsequent decay of nuclear energy levels where in both events, the Moessbauer effect occurs. The spectral distribution of the emitted radiation in the absence of time dependent hyperfine interactions seems well established. The situation is much more complicated if one includes time dependent effects. However, there has been considerable progress made in this case also. The general technique has already been applied to study the nature of the Morin transition in αFe_2O_3 and relaxation effects in magnetite (Fe_3O_4). Further theoretical and experimental results are necessary in order to properly evaluate to power of the method.

RADIATION EFFECTS

1132 (AERE-R—8956) **Theoretical investigation of electron microscope observations of fission gas bubble distributions in a mixed oxide fast reactor fuel pin.** Wood, M.H.; Hayns, M.R. (UKAEA, Harwell. Atomic Energy Research Establishment). Nov 1977. 16p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Calculations have been made, using the random migration model of fission gas behaviour in fast reactor fuel, to correlate with transmission electron microscope observations of gas release and bubble size populations. It is shown that within the present model the observations are consistent with a re-solution rate some two orders of magnitude higher than previously thought applicable to these conditions. The consequences for the interpretation and prediction of fission gas behaviour are discussed.

1133 Mechanism of formation of defects in p^- and n-type Ge converted to p-type by irradiation at 77 °K. Gerasimov, A.B. *Sov. Phys. - Semicond. (Engl. Transl.);* **12**: No. 6, 709-710(Jun 1978).

Irradiation of n-type Ge with fast electrons at 77 °K converts this material to p-type. The properties of such converted samples are very similar to p-type (unconverted) Ge bombarded with fast electrons. This is attributed to the formation of amphoteric radiation effects in both cases.

1134 Influence of radiation on semiconductors with an inhomogeneous impurity distribution. Vinetskii, V.L.; Kondrachuk, A.V. (Institute of Physics, Academy of Sciences of the Ukrainian SSR, Kiev). *Sov. Phys. - Semicond. (Engl. Transl.);* **12**: No. 5, 498-501(May 1978).

A theoretical derivation is given of a model which describes the change in the profile of the periodic distribution of an electrically active impurity caused by the formation of compensating (vacancy—impurity) defects as a result of homogeneous irradiation. Two cases are discussed: 1) annealing of vacancies introduced at low temperatures; 2) simultaneous annealing and introduction of vacancies. Approximate analytic and numerical solutions are obtained for systems of nonlinear equations describing these situations. The conditions facilitating enhancement and smoothing out of inhomogeneities of the initial impurity distribution are determined. A strong dose dependence of the change in the impurity distribution profile is predicted for the case when the concentration of introduced vacancies is close to the minimum impurity concentration before irradiation. It is shown that for real irradiation parameters the cases under discussion give similar results.

CHEMISTRY

1135 Importance sampling and histogrammic representations of reactivity functions and product distributions in Monte Carlo quasiclassical trajectory calculations. Faist, M.B.; Muckerman, J.T.; Schubert, F.E. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). *J. Chem. Phys.;* **69**: No. 9, 4087-4096(1 Nov 1978).

The application of importance sampling as a variance reduction technique in Monte Carlo quasiclassical trajectory calculations is discussed. Two measures are proposed which quantify the quality of the importance sampling used, and indicate whether further improvements may be obtained by some other choice of importance sampling function. A general procedure for constructing standardized histogrammic representations of differential functions which integrate to the appropriate integral value obtained from a trajectory calculation is presented. Two criteria for "optimum" binning of these histogrammic representations of differential functions are suggested.

These are (1) that each bin makes an equal contribution to the integral value, and (2) each bin has the same relative error. Numerical examples illustrating these sampling and binning concepts are provided.

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 1142, 1231, 1271, 1313, 1410, 1411, 1412

CHEMICAL PROCEDURES

1136 (UCRL—52393) **Ion-selective electrodes in organic elemental and functional group analysis: a review.** Selig, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Nov 1977. Contract W-7405-ENG-48. 132p. Dep. NTIS, PC A07/MF A01.

The literature on the use of ion-selective electrodes in organic elemental and functional group analysis is surveyed in some detail. The survey is complete through Chemical Abstracts, Vol. 83 (1975). 40 figures, 52 tables, 236 references.

1137 (Y—2131) **Nuclear magnetic resonance study of 2,6-diisopropylaniline [2,6-DIPA] and 4,4'-methylenebis (2,6-diisopropylaniline) [MDIPA].** Dorsey, J.G.; Smithwick, R.W.; Rutenberg, A.C.; Tomlinson, E.H.; Dorsey, G.F. (Oak Ridge Y-12 Plant, TN (USA)). 30 Aug 1978. Contract W-7405-ENG-26. 28p. Dep. NTIS, PC A03/MF A01.

Impurities in 4,4'-methylenebis(2,6-diisopropylaniline) [MDIPA], a curative for adhesives, were characterized by proton and fluorine nuclear magnetic resonance spectroscopy. The starting material that is used to synthesize MDIPA (2,6-diisopropylaniline) [2,6-DIPA] was also analyzed. It is now possible to identify and quantitatively measure the impurities in various batches of these materials.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 82, 1264, 1274, 1309, 1310, 1311, 1371

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 113, 1281, 1318, 1320

1138 (CONF-780699—1) **Detection of atypical bile acids in disease states and their identification by gas chromatography-mass spectrometry-computer techniques.** Szczepanik-Van Leeuwen, P.A.; Stellaard, F. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 22p. Dep. NTIS, PC A02/MF A01.

From 5. meeting on the biological effects of bile acids; Freiburg, F.R. Germany (12 Jun 1978).

The study of the bile acid constituents of serum, bile, urine, and stool of patients exhibiting liver disease has increased in importance with the availability of newer methods for their detection and identification. A cogent question for study has been whether specific bile acids are toxic and thus are the cause of liver disease, or whether they accumulate as a result of disease-induced alteration in metabolism. Examining a wide variety of clinical samples, we have observed that many patients with diagnosed cholestasis show the presence of atypical bile acids due to metabolic aberrations in either the side chain or in the steroid ring. Because cholestasis represents a spectrum of diseases with differing metabolic and/or anatomic defects and because our studies cover a variety of cholestatic states, we have sought to establish a correlation between the presence of these atypical bile acids and the disease state. The complexity of the bile acid mixtures to be examined requires that gas chromatographic-mass spectrometric-computer techniques be used to provide a reliable analysis. It is believed that atypical bile acids can be readily identified by GC/CI mass spectrometry with great sensitivity. It is also believed that such bile acid analysis may prove useful to the study and diagnosis of liver disease. Present data suggest that the identification of atypical bile acids in biological samples may enable differentiation between different types of intrahepatic cholestasis. Such analyses may prove useful to distinguish specific diseases, such as Byler's disease (and Byler's-like cholestasis) from other types of cholestasis and may distinguish diseases involving mitochondrial defects. Finally, the presence of atypical bile acids may indicate, by the particular compounds formed, where and what kind of damage occurs in a disease and may ultimately establish if these atypical bile acids are a cause or effect of the liver damage.

1139 (DP—1492) **Mass spectrometer for accurate hydrogen isotopic analyses.** Chastagner, P. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Aug 1978. Contract EY-76-C-09-0001. 28p. Dep. NTIS, PC A03/MF A01.

A theoretical study of the mass spectrometric analysis of mixtures of the hydrogen and helium isotopes shows that mass discrimination and low ion intensity in ion sources are the principal factors that limit accuracy. A virtual-image ion source with short focal length and high brightness avoids these limitations. Suitable analyzers and accessory equipment are available. Development and construction of an ion source with the required characteristics are within the state of the art of mass spectrometry. A high-resolution mass spectrometer with a satisfactory ion source should routinely analyze mixtures of the hydrogen and helium isotopes accurately within +-0.5 percent relative (99.7 percent CL) with ordinary operating techniques. Isotopic equilibrium, auxiliary helium analyses, and accurate standard would not be needed. Analyses accurate within +-0.3 percent relative (99.7 percent CL) could be made by using accurately mixed standards.

1140 (UCID—17751) **Operational manual for microwave multigas analyser.** Hrubesh, L.W.; Maddux, A.S.; Johnson, D.C.; Morrison, R.L.; Nielsen, J.N.; Malachosky, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1978. Contract W-7405-ENG-48. 113p. Dep. NTIS, MF A01.

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The microwave multi-gas analyzer is a compact, simple to operate instrument which is designed to specifically detect and monitor the following in air: acetaldehyde, acetone, acetonitrile, carbonyl sulfide, ethanol, ethylene oxide, isopropanol, methanol, propylene oxide, and sulfur dioxide. Additional compounds can be added to the instruments capability if they meet certain requirements. The instrument is transportable; the spectrometer itself weighs less than 18 kg and the auxiliary vacuum gear is enclosed in a movable cart. The instrument can be powered either from 115 VAC or 12 VDC. With battery power and a liquid nitrogen Cryo-pump, the instrument is self-contained and can operate truly portable. The instrument employs rotational resonance absorption spectrometry.

1141 **Optical and dielectric functions of liquid glycerol from gas photoionization measurements.** Birkhoff, R.D.; Painter, L.R.; Heller, J.M. Jr. (Department of Physics and Astronomy, University of Tennessee, Knoxville, Tennessee 37916). *J. Chem. Phys.;* **69**: No. 9, 4185-4188(1 Nov 1978).

In the vacuum ultraviolet spectral region, all solids strongly absorb electromagnetic radiation. Thus, optical properties of liquid surfaces must be obtained from reflectance measurements on a sample exposed to near vacuum rather than from a conventional closed-cell arrangement. In the first application of a new reflectance method which measures photon intensities before and after reflection by gas ionization, we have redetermined the optical functions of glycerol. The new data agree generally with those published before in the region of overlap and extend to a higher energy, 24.4 eV. Although the reflectance between 12 and 18 eV is slightly higher than reported previously, the interpretation of dielectric data calculated from the reflectance is unaltered. The plasmon energy now appears to the at 22 eV instead of the value of 20.4 eV measured earlier.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 353

INORGANIC AND PHYSICAL CHEMISTRY

1142 (UCID—15644-78-1) **General Chemistry Division quarterly report, January—March 1978.** Harrar, J.E. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jun 1978. Contract W-7405-ENG-48. 54p. Dep. NTIS, PC A04/MF A01.

Analytical research and development work is reported on mode-locked krypton ion laser, applications of holographic interferometric microscopy, atomic fluorescence isotope determinations, photoelectrochemistry, nonaqueous titrimetry, determination of furoxans, potentiometric determinations of anions, analysis of explosive composites, determination of noble gases, computer program development, oil chromatography, shale oil characterization, formation of solids in brine, multiple-gas analyzer development, and emission spectroscopy of water. (JRD)

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 60, 61, 816

1143 (ORO—1797-82) **NMR studies of structures of lanthanide dicarboxylate complexes in solution.** Choppin, G.R.; Kullberg, L. (Florida State Univ., Tallahassee (USA). Dept. of Chemistry). [nd]. Contract EY-76-S-05-1797. 17p. Dep. NTIS, MF A01.

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PMR pand ^{13}C shift data were measured for complexes of Pr(III), Eu(III) and Yb(III) with ethylene 1,2-dioxydiacetate (EDODA), ethylene 1,2-dithiodiacetate (EDSDA), and ethylene, 1,2-diaminodiacetate (EDDA). Solubility problems limited analysis of the EDSDA and EDDA data to qualitative evaluation. In the EDSDA complexes, the data indicate that the sulfur atoms do not participate in bonding to the lanthanide cations. Moreover, both carboxylate groups seem to bind Pr and Eu while Yb interacts with only a single carboxylate group. The EDDA complexes are tetradentate with long lived (NMR scale) Ln-N bonds. Shift theory allowed more quantitative analysis of the EDODA complexes. They are tetradentate with a puckered chelate ring and Ln-O(ether) distances of 2.3 A.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

1144 (COO—4294-1) **Calculations on isotope separation by laser induced photodissociation of polyatomic molecules. Progress report, February 1, 1977—June 30, 1978.** Lamb, W.E. Jr. (Arizona Univ., Tucson (USA)). Jul 1978. Contract EN-77-S-02-4294. 29p. Dep. NTIS, PC A03/MF A01.

The molecule SF_6 is treated as a classical dynamical system obeying Newton's laws of motion. This report describes how the current SF_6 potential is determined. The initial approach is described in terms of a pair of Lennard—Jones potential functions with arbitrary coefficients. A method for determining the potential constants is developed. The SF_6 spectrum was reproduced by including three-body forces. By specifying certain parameters such as the $1/r^6$ F-F constant and the total dissociation energy of the molecule, a satisfactory global potential was obtained. The laser-molecule interaction energy was developed. (DLC)

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 1075, 1686

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 1442

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 1144

1145 (AD-A—051336) **Photoisomerization of bis(9-anthryl)methane and other linked anthracenes. The role of excimers and biradicals in photodimerization. Technical report No. 7, 1 November 1976—31 December 1977.** Bergmark, W.R.; Jones, G. II; Reinhardt, T.E.; Halpern, A.M. (Boston Univ., MA (USA). Dept. of Chemistry). 1 Mar 1978. Contract N00014-76-C-0442. 43p. NTIS PC A03/MF A01.

A series of linked anthracenes capable of storing photon energy through endoergic valence photo-isomerization have been studied. Photophysical and photochemical characteristics of the systems have been completely characterized by measurement of fluorescence quantum yields and lifetimes, and efficiencies for forward and reverse isomerization. The release of energy stored in photoisomers has been measured using kinetic and calorimetric techniques. From emission and lifetime data the respective roles of excimers and biradicals in anthracene photodimerization have been defined. (Author)

RADIATION CHEMISTRY

1146 (NDRL—1904(Q-84)) **Quarterly report, April 1, 1978—June 30, 1978.** (Notre Dame Univ., IN (USA). Radiation Lab.). 13 Jul 1978. Contract EY-76-C-02-0038. 45p. Dep. NTIS, PC A03/MF A01.

Abstracts of reports issued during the second quarter of 1978 are provided. Investigations in progress include: solvated electrons; reevaluation of thermalization length distribution in hydrocarbons partially diffusion-controlled reactions in condensed media; field shaping of initial distributions; electron affinity of the water dimer; representation of multi-center electrostatic potentials; coupling matrix elements in ion-ion recombination reactions; vibrational form factors in electron-molecule collisions; calculation of collision-induced spectrum line shapes; some electron reactions and transport from the statistical mechanical point of view; radiolysis studies on hydrocarbon reactions; one-electron oxidation potentials of dihydroxy- and diamino-benzenes; reactions of OH radical with anisole and phenol; reactions of t-butoxyl radicals with phenols; radiolysis of Co(II)nitrilotriacetate; reactions of hydroxamic acid-Fe(III) complexes with solvated electrons; synthesis of stable crystalline biradical molecules; photochemistry of 1,4-diazabicyclo-(4.1.0)-hept-4-enes and related oxiranes; production of singlet molecular oxygen; photochemistry of duroquinone in aqueous solvents; photochemical properties of macrocyclic complexes; photoenolization as a possible way of preventing polymer photodegradation; reaction of ozone with fatty acid monolayer; studies of fatty acid micelles using a phase sensitive probe; solubilization of neutral arenes in ionic micellar solutions; separation and quantification of trace isomeric hydroxy anisoles; measurement of electron spin lattice relaxation times; anomalous behavior of thermal electron attachment to N_2O; vibrational spectroscopy of radical ions; dynamical theory of reaction in organized molecular systems; and photoinduced transitions. (LK)

1147 (ORO—3106-69) **Radiation chemistry of hydrocarbon and alkyl halide systems. Progress report, August 1, 1977—August 1, 1978.** Hanrahan, R.J. (Florida Univ., Gainesville (USA)). 1978. Contract EY-76-S-05-3106. 29p. Dep. NTIS, PC A03/MF A01.

Progress of experimental work is reported on pulse radiolysis of simple alkyl halides in the gas phase, gas phase radiolysis of CHF_3-CH_3I mixtures, gamma radiolysis of the system CO/H_2, and improvements in equipment and facilities. (JRD)

1148 (ORO—4062-50) **Eldor investigations of radiation processes. Annual progress report, 1977—1978.** Kispert, L.D. (Alabama Univ., University (USA). Dept. of Chemistry). 1978. Contract EY-76-S-05-4062. 24p. Dep. NTIS, PC A02/MF A01.

Research is reported devoted to examining the role of the host matrix as a function of temperature in determining the type and yield of radicals produced by X-irradiation of a crystalline or glass material using electron-electron double resonance (ELDOR), electron-nuclear double resonance (ENDOR), electron spin resonance (ESR), and heavy atom substitution techniques. After many years of research on the effects of radiation on crystalline materials, it is still difficult to predict from the thermal history, nature of radiation, crystal structure or form of the parent molecule what radical species will be stable at any given temperature. However, an examination of the ELDOR spectra of an irradiated substance results in a partial or complete measure of the relaxation mechanisms which, in turn, are related to the host matrix itself. The host matrix can be charged slightly by using the heavy atom substitution technique, by using different methods of crystallization, and by including radical precursors in clathrates, permitting a study of the relation among host matrix variation, radical yield, and relaxation parameters. ESR investigations carried out on single crystals of irradiated fluoro, chloro, and bromo derivatives of acetamide and acetic acid have shown that a large matrix effect is present which is dependent upon the leaving group size, crystal structure and degree of crystallization. ELDOR measurements between $5^{\circ}K$ and $370^{\circ}K$ have shown a large variation in ELDOR intensity dependent on intramolecular motion, quadrupole coupling, p-orbital anisotropy, spin diffusion and tunnelling rotation. Forbidden esr lines overlapped by intense esr lines, esr lines too broad to detect, ENDOR transitions and radical cluster have been studied by ELDOR.

1149 (UCLA—12-1149) **Early events in the radiolysis of DNA: studies with model compounds.** Myers, L.S. Jr. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1977. Contract EY-76-C-03-0012. 5p. (CONF-771254—1). Dep. NTIS, PC A02/MF A01.

From 9. Caribbean chemical conference; San Juan, PR, USA (8 Dec 1977).

The review illustrates the progress that has been made in recent years in understanding the radiation chemistry of nucleic acids. Many questions remain to be answered, but already the field is moving towards determining the nature of damage which actually occurs in living organisms, and applying present knowledge to developing agents to modify effects of radiation in vivo.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

1150 (PNL-SA—6858) **Electropolishing as a decontamination process: progress and applications.** Allen, R.P.; Arrowsmith, H.W.; Charlot, L.A.; Hooper, J.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1978. Contract EY-76-C-06-1830. 63p. Dep. NTIS, PC A04/MF A01.

Research studies demonstrated the ability of electropolishing to reduce the radiation levels of steel tools and stainless steel vacuum system components, which were heavily contaminated with plutonium oxide, from 1 million dis/min x 100 cm^2 to background in less than 10 min. Other examples of objects that have been decontaminated within minutes using electropolishing include hot cell manipulator assemblies, analytical instrument components, laboratory transfer containers, offsite shipping containers, fission product storage cap-

sules, laboratory animal cages, and nuclear reactor process tube components. One of the major activities of this research has been the establishment and intensive operation of a 400-gal immersion electropolishing system. Progress has also been made in developing in situ electropolishing techniques that can be used to decontaminate metallic surfaces that cannot readily be transported to or immersed in a conventional electropolishing tank. Sectioning/pretreatment studies are under way to develop and demonstrate optimum disassembly, sectioning, surface preparation, and gross contamination removal procedures. Arc saw, plasma arc torch, and explosive cutting techniques are being evaluated in terms of the thickness and characteristics of the disturbed metal layer. Some of the pretreatment methods under consideration for removal of paint, grease, corrosion layers, and gross contamination include vibratory finishing, ultrasonics, dry and liquid abrasive blasting, and high-pressure spray systems. Other supporting studies are also in progress to provide a sound technical basis for scale-up and widespread application of this new decontamination process. 44 figures. (DLC)

COMBUSTION CHEMISTRY

REFER ALSO TO CITATION(S) 164

1151 (LBL—7843) **Motion of particles in a thermal boundary layer.** Schefer, R.W.; Agrawal, Y.; Cheng, R.K.; Robben, F.; Talbot, L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 15 Jun 1978. Contract W-7405-ENG-48. 6p. (CONF-780733—1). Dep. NTIS, PC A02/MF A01.

From 3. workshop on laser velocimetry; West Lafayette, IN, USA (11 Jul 1978).

In the course of using laser Doppler velocimetry to study combustion in a thermal boundary layer, the particle count rate was found to decrease abruptly to zero inside the boundary layer. Experimental and theoretical investigation of this phenomenon was carried out. The motion of the particles may be due to the combined effects of thermophoresis and radiative heating.

ENGINEERING

REFER ALSO TO CITATION(S) 839

FACILITIES AND EQUIPMENT

1152 (LBL—7905) **Computer aided design of solonoid magnets.** DeOlivares, J.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1978. Contract W-7405-ENG-48. 53p. Dep. NTIS, PC A04/MF A01.

Thesis.

Computer programs utilizing Legendre functions and elliptic integral functions have been written to aid in the design of solenoid magnets. The field inside an axisymmetric magnet can be expanded in a converging power series of Legendre functions. The Legendre function approach is very useful for designing solenoid magnets with a high degree of field uniformity. This approach has been programed on the LBL CDC 7600 computer so that one can design an axisymmetric magnet which meets any desired field structure. Two examples of computer designed solenoids are presented. A computer program utilizing elliptic integral functions was also written for the LBL CDC 7600 computer. This method was used in a computer program to verify the results obtained from the Legendre approach and for field calculations within the conductor. The elliptic integral field calculations within the conductor showed that thin solenoids produce field peaking at the ends of the magnet. Computer data is generated for various magnet geometries and compared with theoretical predictions. Computer results and theoretical prediction both show that field peaking is reduced for longer coils, increased for thinner coils and field peaking is a logarithmic function of length, thickness and radius.

1153 (SAND—77-1290) **Preliminary evaluation of Kevlar-29 versus nylon by SLAP/TV free-flight deployment tests of 12.5-foot-diameter ribbon parachutes.** Pepper, W.B. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 31p. Dep. NTIS, PC A03/MF A01.

A series of twelve sled-launched tests were conducted to evaluate the suitability of Kevlar-29 as a replacement for nylon in parachute construction. Kevlar-29 was found to be a suitable replacement for nylon in parachute construction with an attendant 50% savings in weight and volume. However, different design techniques than those used for all-nylon parachutes were found to be necessary when horizontal ribbons made of Kevlar-29 were used.

1154 (SAND—78-0999) **Flight dynamic instabilities of fluid filled projectiles.** Vaughn, H.R. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 43p. Dep. NTIS, PC A03/MF A01.

Small perturbation velocities are induced in a fluid filled projectile by the spinning and nutational motion that results in an angular momentum asymmetry. This asymmetry can cause a rapid despin and an increase in the nutational motion that can result in instability of a fluid-filled projectile.

1155 (Y/EN—199) **Problems in masonry walls: a case history.** Fricke, K.E.; Jones, W.D.; Beavers, J.E. (Oak Ridge Y-12 Plant, TN (USA)). 1978. Contract W-7405-ENG-26. 18p. (CONF-780817—1). Dep. NTIS, PC A02/MF A01.

From North American masonry conference; Boulder, CO, USA (14 Aug 1978).

This paper briefly discusses the masonry wall failures encountered at Union Carbide Corp.-Nuclear Division facilities in Oak Ridge, TN, their probable causes, and their solutions. The main discussion focuses on two specific failures at the Y-12 plant. These failures involved substantial wall movements in two of the multistory buildings that took place during the past three years. In the first case the entire curtain wall was removed and replaced, and in the second case only the brick veneer was replaced.

1156 **Development of a laboratory EXAFS facility.** Knapp, G.S.; Chen, H.; Klippert, T.E. (Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **49**: No. 12, 1658-1666(Dec 1978).

The EXAFS technique is a powerful new structural tool, particularly useful for studies of disordered or otherwise complex materials for which x-ray diffraction techniques are difficult or unfeasible. At the present time, most EXAFS experiments are carried out at a synchrotron facility because of the larger fluxes available. We have developed an in-laboratory apparatus utilizing a focusing crystal technique which increases available fluxes two to three orders of magnitude over previous laboratory facilities, so that EXAFS measurements can be carried out quickly and accurately in the laboratory. We will discuss the principles of the focusing monochromator and we will also illustrate the experimental method with examples, including studies of chemical solutions, defect crystalline solids, and high-temperature superconductors.

1157 **Temperature-compensated induction extensometer.** Yazdi, A.R.; Deeds, W.E.; Dodd, C.V. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Rev. Sci. Instrum.;* **49**: No. 12, 1684-1687(Dec 1978).

A linear displacement transducer, or extensometer, has been designed and constructed to measure displacements over a range of 0—150 mm. The transducer works by electromagnetic induction and consists of a bifilar coil coaxial with two conducting cylinders, one inside and the other outside the coil. The induction extensometer has been designed to eliminate errors caused by temperature changes from 0° to 1000°C. Experimental measurements show an error of 1 mm over the 150-mm displacement range for a temperature change of 500°C, and the error should not be larger over the full 1000°C temperature range. The displacement range can be varied from 2.5 to 250 mm by scaling the entire experiment up or down, and the temperature compensation can be made for any temperature range that is compatible with the constructional materials.

1158 **Radiology method and apparatus.** Hounsfield, G.N. (to EMI Ltd.). US Patent 3,956,633. 11 May 1976. Priority date 8 May 1974, United Kingdom of Great Britain and Northern Ireland (UK). 8p.

In a radiological apparatus, arranged to produce a representation of the variation of absorption of penetrating radiation over a planar, cross-sectional slice of a body under examination, the radiation emergent from the body along a plurality of paths in the plane of the slice is detected by detector means including one or more photomultipliers. The output signals from the photomultiplier or photomultipliers are monitored and compared with upper and lower threshold levels which represent the extremes of substantially linear operation of the photomultiplier or photomultipliers. In the event of the output signals departing from the range defined by said threshold levels a correction signal is generated and utilized to tend to restore the output signals within said range.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 2071

1159 (LBL—7934) **Computer design and optimization of cryogenic refrigeration systems.** Green, M.A.; Pines, H.S.; Doyle, P.A.

(California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1978. Contract W-7405-ENG-48. 10p. (CONF-780718—4). Dep. NTIS, PC A02/MF A01.

From 7. cryogenic engineering conference; South Kensington, London, UK (4 Jul 1978).

The design and optimization of a cryogenic refrigerator using the LBL computer program GEOTHM are described. This computer program has been used extensively to design and optimize geothermal power plants and power cycles of other types. GEOTHM can calculate the thermodynamics of a wide variety of cycles including refrigeration cycles. GEOTHM has an optimizer which permits single step multiparameter optimization of a thermodynamic cycle. A refrigeration cycle may be optimized for minimum cost refrigeration, or maximum thermodynamic performance using up to 55 optimizable parameters. The use of the optimizer in GEOTHM is demonstrated on two liquid nitrogen refrigeration cycles which are optimized for minimum refrigeration cost and minimum input power.

1160 (NBS—78-02) **Superconducting devices and materials. A literature survey issued quarterly, April—June 1978.** Edelsack, E.A.; Olien, N.A.; Schiffmacher, S.A.; Nisenoff, M.; Wolf, S.A.; Clark, A.F.; Ekin, J.W.; Fickett, F.R. (National Bureau of Standards, Boulder, CO (USA). Cryogenic Data Center). 1978. 57p. National Bureau of Standards, Boulder, CO.

Highlights of the literature on superconducting devices and materials are presented. The highlights are followed by a bibliography of approximately 760 references. (TFD)

1161 (NP—23252) **Three-dimensional analytical field calculation for a turbogenerator with superconducting exciter winding.** Echtler, K.W. (Technische Univ. Muenchen (Germany, F.R.). Fachbereich Elektrotechnik). 27 Jul 1976. 263p. (In German). Dep. NTIS (US Sales Only), PC A12/MF A01.

Thesis.

The Fourier analysis of the rotor and stator current envelope is treated for spatial sine waves. The final width of the rotor and stator conductors is included in the calculation. Subsequently, the equations for the vector potential of the stator and rotor winding are produced. The magnetic field which is formed if ideal radial edge conditions are present is formed by the superimposition of the fields from the additional vector potentials and the fields from the original vector potentials. In addition to the field calculation, there is a calculation of the magnetic flux and the self-inductance associated with the rotor and with one branch of the stator winding. The theory is checked by measurements on a model of a two pole turbine rotor. The measured results fit well with the calculation, which was carried out on a digital computer.

1162 Mutual inductance bridge for low-temperature thermometry and susceptibility measurements. Whitmore, S.C.; Ryan, S.R.; Sanders, T.M. Jr. (Department of Physics and Astronomy, University of Oklahoma, Norman, Oklahoma 73019). *Rev. Sci. Instrum.;* **49**: No. 11, 1579-1582(Nov 1978).

We describe a solid-state mutual inductance bridge suitable for low-temperature thermometry and susceptibility measurements. The design features an electronically simulated variable mutual inductance. Particular care is taken to reduce spurious capacitive effects. The bridge is highly stable and linear. It has a resolution of 10^{-4} over the range 15 μH to 150 mH, and a noise limited sensitivity of 55 I/sub p/$^{-1}$ nH with a l-s time constant, where I/sub p/ is the rms primary current in mA. Application to thermometry is discussed.

1163 Studies on a combined superconducting coil for high field magnets. Katsurai, M. (Tokyo Univ. (Japan). Faculty of Engineering). *Teion Kogaku;* **12**: No. 6, 230-239(Dec 1977). (In Japanese).

A combined superconducting coil is proposed for the purpose of increasing the strength of magnetic fields generated by large-scale superconducting magnets where alloy type NbTi wires of the fully stabilized type are utilized as main windings. The coil is provided by numbers of high-field composite superconducting wires produced by the compound type (Nb_3Sn, V_3Ga) material which are arranged as partial by-passes of the exciting current in regions exposed to strong magnetic field higher than the critical value of the superconducting material of the main windings. The arrangements of the high-field wires are made in such a manner as they are in tight contact with (parallel type) or in place of (series type) the portions of the main windings in the respective turns in the high field regions. In either type, the Joule heat is generated by the current flowing through the normal conducting matrices of the connecting regions, and this heat is removed by the cryogenic Helium directly contacting with the winding surfaces. The amount of this excessive heat loss is in the range of 1 kW -- 10 kW for the large scale (10^{10} -- 10^{13}J) magnet practically used in fusion reactors or energy storage devices where the average field is about 8T and the maximum field is in the range of 14 -- 17T.

PROTECTIVE STRUCTURES AND EQUIPMENT

REFER ALSO TO CITATION(S) 1320

1164 (CONF-780819—23) **Progress in standards for nuclear air and gas treatment.** Burchsted, C.A. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Standardization in nuclear air and gas treatment spans a period of more than 25 years, starting with military specifications for HEPA filters and filter media, and now progressing to the development of a formal code analogous to the ASME Boiler and Pressure Vessel Code. Whereas the current standard for components and installation of nuclear air cleaning systems is limited to safety related facilities for nuclear power plants, the proposed code will cover all types of critical ventilation and air and gas treatment installations for all types of nuclear facilities.

1165 (LA—7397-M) **TVENT: a computer program for analysis of tornado-induced transients in ventilation systems.** Duerre, K.H.; Andrae, R.W.; Gregory, W.S. (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 104p. Dep. NTIS, PC A06/MF A01.

The report describes TVENT, a portable FORTRAN computer program for predicting flows and pressures in a ventilation system subject to a tornado. The pressure and flow values calculated by TVENT can be used as a basis for structural analysis. TVENT is a one-dimensional, lumped-parameter model with incompressible flow augmented by fluid storage. The theoretical basis for the mathematical modeling and analysis is presented, and a description of the input for the computer code is provided. Modeling techniques specific to ventilation systems are described. Sample problems illustrate the use of TVENT in analyzing ventilation systems. Other sample problems illustrate modeling techniques used in reducing complex systems.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 347

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 354

1166 (UCID—17895) **Thermal analyses of the IF-300 shipping cask.** Meier, J.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1978. Contract W-7405-ENG-48. 53p. Dep. NTIS, PC A04/MF A01.

In order to supply temperature data for structural testing and analysis of shipping casks, a series of thermal analyses using the TRUMP thermal analyzer program were performed on the GE IF-300 spent fuel shipping cask. Major conclusions of the analyses are: (1) Under normal cooling conditions and a cask heat load of 262,000 BTU/h, the seal area of the cask will be roughly 100°C (180°F) above the ambient surroundings. (2) Under these same conditions the uranium shield at the midpoint of the cask will be between 69°C (125°F) and 92°C (166°F) above the ambient surroundings. (3) Significant thermal gradients are not likely to develop between the head studs and the surrounding metal. (4) A representative time constant for the cask as a whole is on the order of one day.

TRANSPORT AND STORAGE FACILITIES

1167 (ORNL/TM—6290) **Estimating the cost of product water conveyance from desalination plants.** Reed, S.A.; Marsh, M.L. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

Methods are presented for estimating the costs of transporting, by pipeline, product water from desalination plants. Cost curves are presented for conveying from 19 to 380 x 10^3 m^3/day (5 to 100 Mgd) to distances to 80 km (50 mile). Sand is used as the reference soil, and adjustment factors are given for earth, shale, hard rock, and swampland. Costs are given as a function of distance and include pipeline construction, pumping stations, power lines, and electrical switchgear.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 294, 1237, 1243

1168 (CONF-780825—P3, pp H2.1-H2.12) **Study to determine roller cone cutter offset effects at various drilling depths.** Dropek, R.K. (Terra Tek, Inc., Salt Lake City); Williams, C.R. 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Tests were performed using a single roller cone from a 4$^3/_4$ inch diameter modified chisel bit to evaluate the effects of cutter offset "skew" on drill bit cutting efficiency at depth. Drilling experiments were conducted using Colton Sandstone (11% porosity and 50 μdarcy permeability). Tests were performed at simulated depths ranging from 0 to 20,000 feet using six different offsets (0 to 0.24 inches) and two different penetrations (0.05 and 0.1 inches). A single revolution of the cone arm was made with torque, thrust and the resulting removed volume recorded. The application of test results to future drill bit design are discussed.

1169 (CONF-780825—P3, pp H9.1-H9.15) **Electrodril Field Test Demonstration Program.** Traynor, B.V. Jr.; Taylor, P.D. (General Electric Co., Houston, TX). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

The Electrodril Field Test Demonstration Program is being performed under a May, 1976 cost-sharing contract with the Fossil Energy Division of the U.S. Department of Energy and is funded by the Branch of Drilling and Offshore Technology. The Geothermal Division has also contributed significantly. Phase I and an Interim Phase were completed in August, 1977 when Phase II began. The emphasis of Phase I was on testing the Directional Drilling System which uses a 60 HP downhole electric drilling motor with a real-time telemetry system, a retrievable electric cable and other subsystems. The Phase I results indicate that the system is feasible although several problem areas need improvement. This paper gives a brief review of the work previous to Phase II and discusses the progress of work on Phase II. The Phase II work utilizes a 285 HP downhole electric drill motor, called the Deep Drilling System, with telemetry and a retrievable electric cable. Several problem areas are discussed along with the improvements which have been accomplished. Plans for testing the large drill motor and its sub-systems are discussed including three planned deep field tests.

1170 (CONF-780825—P3, pp H10.1-H10.22) **Mud pulse telemetry system used in directional drilling.** Spinnler, R.F.; Stone, F.A. (Teleco Oilfield Services Inc., Middletown, CT). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

Teleco Oilfield Services, Inc. is currently carrying out a Pilot Service Demonstration program in the Gulf of Mexico to demonstrate Teleco's mud pulse telemetry system applied to directional surveying while drilling. Mud pulse telemetry is a means of sending information from the bottom of a drill string to the drilling platform floor while drilling. Information is conveyed through the mud flowing within the drill string by means of pressure pulses generated by a downhole mud pulse transmitter. Pressure in the flowing mud column is periodically modulated in a binary code by means of a valve in the downhole transmitter, and the resulting periodic pressure pulses appearing at the upper end of the drill string are detected by a pressure transducer conveniently placed in the mud sandpipe. Surface electronic equipment decodes the pressure pulse sequence and displays the data sent up from the bottom of the drill string. The Teleco system transmits directional surveying data, i.e., wellbore inclination, azimuth, and tool facing. Three generations of prototype systems were tested under actual drilling conditions between 1968 and 1977. Over 2700 hours of bottom-hole use were logged. Using eight new production systems Teleco began a Pilot Service Demonstration in August 1977 in the Gulf of Mexico. Each system consists of a directional angle sensor assembly and a mud pulse telemetry transmitter housed within a drill collar. Equipment reliability, as indicated by recent test runs in excess of 250 hours of drilling without failure, is approaching the level needed for commercial service.

LASERS

1171 **Emulsion dye laser.** Matheson, K.L.; Thorne, J.M. (Chemistry Department, Brigham Young University, Provo, Utah 84602). *Appl. Phys. Lett.;* **33**: No. 9, 803-804(1 Nov 1978).

A laser dye which is insoluble in water has been dissolved in hexane and emulsified in a water matrix. When pumped with a nitrogen laser, this mixture was observed to lase. The emulsion is superior to a simple hexane solution because the excellent thermo-optical properties of the water matrix help prevent refractive-index gradients from degrading laser performance. This is a useful characteristic for flash-pumped dye lasers, laser-pumped dye lasers, and liquid filters. Another type of solvent system, a critical solution, is also discussed. For certain dyes, a critical solution has even better thermo-optical properties because of its ability to absorb heat as it undergoes a liquid-liquid phase transition.

1172 (SAND—78-0811) **Laser development for laser fusion applications research. Progress report, October 1977—March 1978.** (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 75p. Dep. NTIS, PC A04/MF A01.

Research progress is reported on three laser programs being developed for the commercialization of laser-fusion energy. The lasers include iodine, hydrogen fluoride and Group VI atoms (e.g., O, S, Se, Te). (TFD)

1173 **Spectrally narrow pulsed dye laser without beam expander.** Littman, M.G.; Metcalf, H.J. (Massachusetts Institute of Technology, Research Laboratory of Electronics and Department of Physics, Cambridge, Massachusetts 02139). *Appl. Opt.;* **17**: No. 14, 2224-2227(15 Jul 1978).

We have developed a simplified version of the side-pumped pulsed dye laser which has a spectral halfwidth of 1.25 GHz and a peak power of 10 kW at 600 nm. The basic laser consists of only four components (output mirror, dye cell, diffraction grating, and tuning mirror) and is exceptionally easy to align. Since the beam expander has been eliminated, the laser cavity can be made quite compact. Under the condition of reduced gain, the laser has been operated in a single mode.

1174 **Investigation of defect generation in the active regions of double AlGaAs heterostructures at high optical excitation rates.** Alferov, Z.I.; Agafonov, V.G.; Andreev, V.M.; Garbuzov, D.Z.; Lantratov, V.M.; Rumyantsev, V.D. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Semicond. (Engl. Transl.);* **12**: No. 6, 626-629(Jun 1978).

An investigation was made of defect generation in double Al/sub x/Ga/sub 1-x/As heterostructures by optical excitation of the active region. It was found that one of the principal factors governing defect generation was the appearance of mechanical stresses in the narrow-gap active region. When these stresses were compensated, the results obtained indicated that the continuous service life of heterojunction lasers made of these structures could exceed 2 x 10^4 h.

1175 **Electron-microscopic investigation of defects in injection lasers.** Mil'vidskii, M.G.; Morgulis, L.M.; Osvenskii, V.B.; Pak, G.T. (State Scientific-Research and Design Institute of the Rare-Metal Industry, Moscow). *Sov. Phys. - Semicond. (Engl. Transl.);* **12**: No. 6, 707-708(Jun 1978).

Double-sided confinement lasers composed of four alternate layers of Ga/sub 1-x/Al/sub x/As and GaAs were examined in a JEM-150 electron microscope under an acceleration voltage of 150 kV. Such examination revealed defects elongated along the <100> directions, called in the literature "dark-line defects" and consisting of three-dimensional dislocation tangles.

1176 **Characteristics of laser glasses (review).** Avakyants, L.I.; Buzhinskii, I.M.; Koryagina, E.I.; Surkova, V.F. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 423-434(Apr 1978).

A systematic review is given of the published information on the properties of laser glasses and some characteristics of neodymium glasses of Soviet origin are repoted. The physicochemical, spectral, luminescence, and stimulated emission characteristics of neodymiumactivated laser glasses made in the USSR and foreign firms are reviewed.

1177 **Continuous-wave dye laser tunable by a holographic diffraction grating.** Balykin, V.I.; Klose, E.; Mishin, V.I.; Semchishen, V.A. (Institute of Spectroscopy, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 435-438(Apr 1978).

An investigation was made of the parameters of a cw dye laser tunable by a holographic diffraction grating (2040 lines/mm, first-order reflection R=85% at the wavelength of 580 nm). This grating was placed behind a semitransparent mirror and it produced an output line 10 pm wide; the use of an additional telescope reduced the line width to 2 pm. The emission wavelength was tunable over a range 20—25 nm wide (in the case of rhodamine 6 G). The emission wavelength was controlled simply by the position of the diffraction grating and the output power remained constant throughout the tuning range. For comparison, a study was made of the characteristics of a laser with a selector formed by two prisms and a Fabry—Perot etalon.

1178 **Excitation of high-pressure laser media by a discharge through an insulator.** Ishchenko, V.N.; Lisitsyn, V.; Sorokin, A.R. (Institute of Semiconductor Physics, Siberian Branch of the Academy of Sciences of the USSR, Novosibirsk). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 453-457(Apr 1978).

A method is considered for exciting high-pressure laser media by a discharge through an insulator. The parameters of insulating materials which determine the energetics of a discharge suitable for exciting various laser media are found. It is shown experimentally that the optimum regimes for supplying energy to the discharge for Co_2 lasers and for inert-gas atomic-transition lasers can be achieved using discharges through pyroceramic and glass respectively. A power supply circuit is proposed which enables the quantity E/p in the discharge plasma to be varied over wide limits. It is indicated that this method may be applicable to the excitation of high-pressure cw lasers.

1179 Stimulated emission of light from doped molecular crystals at 4.2 °K. Naboikin, Y.V.; Ogurtsova, L.A.; Podgornyi, A.P.; Malkes, L.Y. (Physicotechnical Institute of Low Temperatures, Academy of Sciences of the Ukrainian SSR, Kharkov). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 457-461(Apr 1978).

Investigations were made of the spectral and energy characteristics of stimulated emission from doped molecular crystals at 4.2 °K. The molecular crystals used were naphthalene, biphenyl, dibenzyl, and fluorene, doped with derivatives of diarylethylenes and diaryldivinylbenzenes, naphthacene, azulene, anthracene, and others. The crystals were excited in the impurity absorption band by the third harmonic of a neodymium laser. The stimulated emission from the doped crystals at 4.2 °K was characterized by a narow line (0.5—5 cm^{-1}) and a stable emission frequency, which did not depend on the excitation energy or the impurity concentration. The stimulated emission from most of the crystals could be tuned continuously in a narrow frequency range by varying the sample temperature. The threshold pump energy density, the coefficient of conversion of the pump energy into stimulated emission energy, and the volume density of the stimulated radiation were determined. The prospects for using molecular crystals at 4.2 °K in laser engineering are discussed.

1180 Frequency shift of the $\lambda=3.39$ μ methane transition in a ring laser field. Belenov, E.M.; Uskov, A.V. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 467-471(Apr 1978).

An investigation is made of the reproducibility of an He—Ne/CH_4 frequency standard with a ring resonator. The dependence of the radiation frequency of such a stabilized laser on the saturation parameter of the absorbing medium is determined. It is shown that "weak" transitions in the hyperfine structure of the methane absorption line substantially influence the behavior of this dependence.

1181 Design of multipass telescopic amplifiers for a cw chemical HF laser. Virnik, Y.Z.; Krutova, V.G.; Mashchenko, A.I.; Oraevskii, A.N.; Stepanov, A.A.; Shcheglov, V.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 505-509(Apr 1978).

The results are given of calculations (carried out within the geometric optics approximation) of the energy parameters of multipass telescopic amplifiers for a cw diffusion HF laser. A brief description is given of the calculation method. Two known types of telescopic amplifier are compared with a conventional single-pass configuration. The dependences of the output parameters on the input signal, resonator gain, and coupling coefficient are investigated.

1182 Investigation of lasing in a hybrid Co_2 laser. Likhanskii, V.V.; Myl'nikov, G.D.; Napartovich, A.P.; Semerok, A.F.; Sobolenko, D.N. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 512-516(Apr 1978).

Operating regimes of a hybrid CO_2 laser were invesigated. It was shown that the delay of a laser pulse relative to a current pulse in the high-pressure-vessel, and the shape, spectral composition, and energy of the laser pulse depend on the gain in the low-pressure vessel and on the resonator parameters. The experimental results are in agreement with a theoretical description of the operation of a hybrid Co_2 laser.

1183 Influence of wavefront reversal on the operation of Brillouin laser. Gerasimov, V.B.; Orlov, V.K. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 517-518(Apr 1978).

An analysis is made of the ways of constructing a high-efficiency Brillouin laser excited by spatially noncoherent wide-band pump waves.

1184 Possibility of generation of short laser radiation pulses as a result of photolysis of a cooled H_2—F_2 mixture. Bashkin, A.S.; Igoshin, V.I.; Nikitin, V.Y.; Oraevskii, A.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 518-520(Apr 1978).

It is shown theoretically that sufficiently strong optical initiation (pulse duration 1—4 μsec) of a chain reaction in a cooled (to 100—150 °K) hydrogen—fluorine mixture ensures that the HF laser radiation energy is emitted mainly as a short pulse lasting a few tens of nanoseconds. The predicted reaction regime is characterized by a high yield of coherent radiation and is of interest in potential applications of HF lasers in controlled thermonuclear fusion systems.

1185 Investigation of an HF master oscillator—amplifier system based on the chain hydrogen—fluorine reaction. Basov, N.G.; Bashkin, A.S.; Golubev, L.E.; Kozlov, Y.I.; Oraevskii, A.N.; Piskunov, A.K.; Tomashov, V.N.; Troshagin, V.N.; Yuryshev, N.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 520-522(Apr 1978).

The results are given of an experimental investigation of an HF master oscillator—amplifier system based on the chain hydrogen—fluorine reaction. The experiments demonstrate the importance of the matching of the oscillator and amplifier spectra when a high energy yield from the amplifier is required. It is reported that the yield of the active medium of the amplifier can be 73%, compared with the yield in the oscillator regime.

1186 Simple and reliable ultraviolet-emitting molecular nitrogen laser. Antonov, V.S. (Institute of Spectroscopy, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 524-526(Apr 1978).

A nitrogen laser with a hydrogen thyratron switch was constructed. The output energy was up to 4.5 mJ per pulse of 12 nsec duration. The use of mass-manufactured elements ensured reliable operation of the laser and simplified its construction. The laser efficiency was 0.1%, the divergence of the output radiation in the electrode plane was 6×10^{-3} rad and, at right-angles to this plane, it was 2×10^{-3} rad. The time instability of the output pulses was +- 3 nsec relative to the triggering pulses applied to the thyratron grid.

1187 Emission of nanosecond pulses from a CO_2 laser operating under free-oscillation conditions. Adamovich, V.A.; Baranov, V.Y.; Smakovskii, Y.B.; Strel'tsov, A.P. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 526-527(Apr 1978).

A CO_2 laser was excited by ionizing the active medium with an electron beam. The output pulses were of 7×10^{-9} sec duration under free-oscillation conditions. The dependences of the pulse duration on the composition of the mixture and the energy characteristics of the laser were determined.

1188 Continuous-wave closed-cycle technological CO_2 laser with 6 kW output power. Artamonov, A.V.; Egorov, Y.A.; Kazhidub, A.V.; Katsuro, N.I.; Lebedev, F.V.; Sidorenko, E.M.; Sumerin, V.V.; Frolov, V.M. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 528-529(Apr 1978).

A cw closed-cycle technological CO_2 laser utilizing a helium-free mixture was constructed and tested. An output power of 6 kW and an electrooptic efficiency of ~8% were achieved.

1189 Modulation of the transmission of an atomic iodine switch. Gaidash, V.A.; Mochalov, M.R.; Shemyakin, V.I.; Shurygin, V.K. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 530-531(Apr 1978).

A study was made of the active modulation of the transmission of an iodine switch based on the Zeeman effect. The switch was bleached in fields of the order of 2 kOe. The duration of the leading edge of the bleaching pulse was 200 nsec.

1190 Efficiency of the excitation of CO_2 in a gasdynamic laser with gas mixing. Ostroukhov, N.N.; Tkachenko, B.K. (Physicotechnical Institute, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 531-532(Apr 1978).

An experimental investigation was made of the inversion characteristics of a gasdynamic CO_2 laser in which cold carbon dioxide was mixed with vibrationally excited nitrogen in a medium of the $H_2O:O_2:N_2=0.16:0.11:0.73$ composition. This medium was heated by burning hydrogen in atmospheric oxygen. For transverse injection in a plane where the Mach number was 3.5 the efficiency of excitation of CO_2 (ν_3) was 0.8 for a molar fraction of CO_2 up to 25%.

1191 Measurement of the gain of an inhomogeneous active medium. Berger, N.K.; Luk'yanov, Y.N. (Polytechnic Institute, Khabarovsk). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 542-543(Apr 1978).

An analysis is made of the transmission of a Gaussian beam by an amplifier with a spatially inhomogeneous active medium. The results are used in estimating the precision of gain measurements by means of a probe beam. It is shown that even a slight inhomogeneity may distort the measured frequency dependences and spatial distributions of the gain.

1192 Pulse-periodic operation of an optically pumped CF_4 laser with an average output power of 0.2 W. Baranov, V.Y.; Vasil'ev, B.I.; Velikhov, E.P.; Gorokhov, Y.A.; Grasyuk, A.Z.; Dyad'kin, A.P.; Kazakov, S.A.; Letokhov, V.S.; Pis'mennyi, V.D.; Starodubtsev, A.I. (Institute of Spectroscopy, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 4, 544-546(Apr 1978).

Stimulated emission of $\lambda=16\ \mu$ radiation was obtained as a result of optical pumping of CF_4 molecules with radiation from a pulse-periodic CO_2 laser. A study was made of the dependences of the output energy on the pump energy, gas pressure, and repetition frequency of the pump pulses. The stimulated emission was observed at pulse repetition frequencies up to 100 Hz. The average output power was up to 0.2 W from a static CF_4 gas. Possibilities of increasing this average power are considered.

1193 Investigation of a laser electron-beam tube under scanning conditions. Kozlovskii, V.I.; Nasibov, A.S.; Pechenov, A.N.; Reznikov, P.V.; Skasyrskii, Y.K. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 281-285(Mar 1978).

An investigation was made of the principal characteristics of a laser electron-beam tube when the beam parameters and scanning velocity were varied. This velocity determined the laser radiation parameters. In the range v/sub sc/<v⁰/sub sc/ the effects associated with the temperature gradient in the excited part of the screen played an important role. In the range v/sub sc/>d/tau there was a reduction in the laser output power and associated increase of the threshold which occurred because the time needed to excite a single element of the cadmium sulfide screen became less than the nonequilibrium carrier lifetime. The minimum threshold and the maximum efficiency were observed in the range v⁰/sub sc/<v<d/tau.

1194 Trapping of resonance radiation and nonlinear interaction of waves in a ring laser. Birman, A.Y.; Savushkin, A.F. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 290-293(Mar 1978).

Exact solution of the kinetic equation with a one-dimensional averaged Keilson—Storer kernel is used to calculate the nonlinear polarizability of the active medium of a ring laser allowing for complete trapping of resonance radiation. An analysis is made of the extent to which the relationships obtained differ from the known results of the theory based on the model of strong collisions. It is shown that radiation trapping may reduce significantly the instability zone of the two-wave stimulated emission.

1195 Water vapor condensation and relaxation processes in a gasdynamic CO_2 laser. Konyukhov, V.K.; Faizulaev, V.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 297-299(Mar 1978).

Calculations of the kinetics of water vapor condensation in a supersonic jet of a CO_2—N_2—H_2O gas mixture expanding through a slit were used as the basis for an investigation of the influence of heterogeneous molecular relaxation on the parameters of the active medium in a gasdynamic CO_2 laser. The results of the calculations were compared with experimental data.

1196 Influence of the interaction between the radiation and the reflector material on the characteristics of a ring laser. Zborovskii, V.A.; Kulikov, V.N.; Pereverzev, A.V.; Tsiguro, N.G.; Shokin, B.A. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 300-302(Mar 1978).

An investigation was made of transient processes in a ring laser leaving the locking band. It was shown that these phenomena were associated with the action of a standing wave on the resonator mirrors, forming a periodic structure on the mirror surface which produced additional coupling between the opposite waves. An approximate model was developed for the formation of this structure. Experiments were carried out which essentially supported the proposed model.

1197 Energy characteristics of a 16μ CO_2 laser pumped optically in the 4.3 and 9.6μ bands. Kuntsevich, B.F.; Stepanov, B.I.; Trushin, S.A.; Churakov, V.V. (Institute of Physics, Academy of Sciences of the Belorussian SSR,Minsk). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 313-318(Mar 1978).

Results are presented of a theoretical investigation of the energy characteristics of a CO_2 molecular laser emitting in the 02^00—01^10 channel (16 μ). It is postulated that the system is pumped by radiation from pulsed HBr and CO_2 lasers in the 4.3 and 9.6 μ bands, respectively. The optimal parameters of the laser are determined. It is shown that at pump energies of $\sim$0.02 J/cm^3, resonator lengths of $\sim$100 cm, loss coefficients of $\sim$0.01 cm^{-1}, and optimal values of the pump pulse duration, pressure, and CO_2—He mixture composition, the efficiency of conversion of the 4.3 μ pump radiation energy into 16 μ stimulated emission energy attains $\sim$4.5%.

1198 Influence of preionization conditions on the development of a homogeneous discharge in gases. Karnyushin, V.N.; Malov, A.N.; Soloukhin, R.I. (Institute of Heat and Mass Transfer, Academy of Sciences of the Belorussian SSR, Minsk). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 319-323(Mar 1978).

The influence of the initial conditions on the development of a homogeneous discharge in the geometry of a typical TEA CO_2 laser was studied, the active medium being preionized by ultraviolet radiation from an auxiliary discharge. It was established theoretically and experimentally that there is a certain range of values of the initial electron density and electric field, within which a volume-discharge regime is realized, and conditions and equations determining the limits of this range were formulated. The physical model developed explains a number of effects which characterize the operation of transversely pumped pulsed gas-discharge lasers.

1199 Spatial and temporal fluctuations of nanosecond radiation pulses in CO_2 amplifiers. Baranov, V.Y.; Kirichenko, T.K.; Klavdiev, V.V.; Petrushevich, Y.; Starostin, A.N. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 327-333(Mar 1978).

Results are presented of the numerical solution of a complete system of equations to describe the propagation of pulses of 10^{-9}—10^{-7} sec duration in CO_2 amplifiers, allowing for intra- and intermode relaxation processes and relaxation of the polarization. It is shown that coherence effects exert an appreciable influence on the space-time profile of the signal being amplified. Various limiting cases are analyzed.

1200 Power-supply circuit and dynamic characteristics of a discharge in a nitrogen laser. Sidorov, Y.L.; Sukhanov, A.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 334-339(Mar 1978).

Results are presented of an experimental investigation into the dynamic characteristics of a pump discharge in a nitrogen laser having an output power of $\sim$1 MW. Absolute values of the energy input to the discharge and of the discharge resistance were measured over a pressure range of 30—300 Torr with a time resolution of $\sim 10^{-9}$ sec. New criteria are considered, on the basis of the results obtained, to act as a guide in developing high-power gas lasers using a Blumlein pulse-shaping line to energize the pump discharge. It is shown that more than 50% of the energy initially stored in the power-supply circuit can be fed into the discharge at a pump power of $\sim$10 MW/cm^3 under overvoltage conditions. The similarity between the dynamic current-voltage characteristics of N_2- and CO_2-laser atmospheric pressure discharges is mentioned. A simple circuit for supplying power to a multimodule laser is proposed, which allows operation as an oscillator—amplifier system. In the amplifier regime, lasing in XeF was obtained with an output energy of $>$ or $\approx$ 20 mJ.

1201 Importance of the nonlinearity of the active medium in the mode locking in a solid-state laser. Khanin, Y.I. (Scientific-Research Institute of Applied Physics, Gorki). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 339-343(Mar 1978).

A theoretical analysis is made of the influence of the parametric interaction between laser modes on their frequency and phase. The threshold conditions for passive mode locking are determined. It is shown that passive mode locking is possible in principle under steady-state operating conditions. Estimates are made which indicate that the nonlinearity of the refractive index of the active-element matrix may be responsible for partial and, under favorable conditions, complete mode locking.

1202 Distribution of electron energies in mixtures of copper vapor with neon and helium. Mnatsakanyan, A.K.; Naidis, G.V.; Shternov, N.P. (Institute of High Temperatures, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 343-346(Mar 1978).

The results are given of calculations of the electron energy distribution function and also of the values of the average energy, drift velocity, and constants of inelastic processes involving electrons under conditions of the kind encountered during operation of copper vapor lasers.

1203 Mode deformation due to self-focusing in injection lasers and its connection with nonlinearity of the output characteristic. Bachert, H.J.; Bogatov, A.P.; Eliseev, P.G. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 346-349(Mar 1978).

The effect of the pump current on the mode configuration of an injection laser with an external selective resonator was studied. It was found that in a single-mode regime, controlled by the external resonator, a number of regularly spaced filamentary channels appear as the pump current is increased. Interference effects give rise to side lobes in the far-field radiation-pattern polar diagram, which are interpreted as being due to self-focusing of the radiation in the active medium, arising from the relationship of the refractive index of the inverted semiconductor with the electron density and the electromagnetic field intensity. The appearance of channels is accompanied by a kink in the energy characteristic of the laser.

1204 Q-switched iodine laser emitting at two frequencies. Katulin, V.A.; Nosach, V.Y.; Petrov, A.L. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 380-382(Mar 1978).

An investigation was made of the characteristics of stimulated emission of short light pulses in a transverse magnetic field. Conditions for simultaneous emission at two frequencies corresponding to the F ′=3→→F=4 and F ′=2→F=2 transitions. In magnetic fields of 0—800 Oe intensity the frequencies of the σ Zeeman components of the above 3—4 and 2—2 transitions coincided with the central frequencies of the corresponding transitions in the luminescence spectrum of atomic iodine in the absence of a magnetic field.

1205 Spatial field configuration in a cavity with nonresonant feedback. Belonuchkin, V.E.; Eskin, N.I.; Kozel, S.M.; Kuznetsov, E.P.; Lokshin, G.R. (Physicotechnical Institute, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 390-392(Mar 1978).

An investigation is made of the spatial characteristics of the field in a cavity one of whose mirrors is replaced by a diffuse reflector with a "wide" scattering indicatrix. A derivation is given of a system of integral equations for the determination of the field correlation function in the cavity and its approximate solution is given. It is shown that the nature of the field correlation function is established after the first reflection: subsequent reflections simply result in small corrections. An estimate is obtained of the field correlation radius in the cavity.

1206 Electron-beam-excited ZnSe—ZnS semiconductor waveguide laser. Petukhov, V.S.; Pechenov, A.N.; Talenskii, O.N.; Khalimon, M.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 400-401(Mar 1978).

A method was developed for growing ZnSe—ZnS waveguide structures. Waveguide effects were observed in these structures. A study was made of the characteristics of electron-beam-excited lasers utilizing these structures. Stimulated emission was observed in the blue part of the spectrum at room temperature.

1207 Stimulated emission at λ=502 nm as a result of prolonged optical pumping of $HgBr_2$ vapor. Bazhulin, S.P.; Basov, N.G.; Zuev, V.S.; Leonov, Y.S.; Stoilov, Y.Y. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 402-403(Mar 1978).

Green luminescence and stimulated emission in the form of ~2 μsec pulses were observed as a result of photodissociation of $HgBr_2$ vapor with radiation from an open high-current discharge. The rates of quenching of the luminescence by various buffer gases were determined.

1208 Characteristics of stimulated emission from LiNdLa phosphate glass. Vodop'yanov, K.L.; Denker, B.I.; Maksimova, G.V.; Malyutin, A.A.; Osiko, V.V.; Pashinin, P.P.; Prokhorov, A.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 403-405(Mar 1978).

An investigation was made of the characteristics of LiNd/sub 0.3/La/sub 0.7/ phosphate glass with $8x10^{20} cm^{-3}$ of Nd^{3+}. These characteristics were obtained under free-oscillation, Q-switching, and pulse-periodic conditions. At moderate pumping rates the emitted radiation consisted of the TEM_{00} mode with near-diffraction divergence. The investigated glass could emit in the pulse-periodic regime at a repetition frequency up to 100 Hz. The maximum average output power was 6.5 W when the pump power was 1 kW.

1209 Reduction in the duration of pulses emitted from atmospheric-pressure CO_2 lasers. Volyak, T.B.; Karlova, E.K.; Karlov, N.V.; Krasyuk, I.K.; Kuz'min, G.P.; Pashinin, P.P. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 406-407(Mar 1978).

A study was made of the possibility of reducing the duration of output pulses of atmospheric-pressure CO_2 lasers by quenching stimulated emission (as a result of intracavity breakdown) and pulse sharpening (as a result of extracavity burning of metallized films). Pulses of 10 nsec duration at midamplitude with 3—4 nsec edges were obtained in this way.

1210 Pressure-tunable cw PbSe injection laser. Zasavitskii, I.I.; Chizhevskii, E.G.; Shotov, A.P. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 408-409(Mar 1978).

A study was made of the influence of hydrostatic pressures up to 1.8 kbar on the emission spectra of a cw PbSe injection laser at temperatures of 4.2 and 20.3 °K. The quasicontinuous tuning range was 8.2—9.2 μ (1090—1220 cm^{-1}). The measured rates of continuous change of the mode frequency with the current and pressure reached +0.01 +- 0.003 cm^{-1}/mA and —0.026 +- 0.001 cm^{-1}/bar. The continuous pressure-tuning range was ~1.7 cm^{-1}. At 20.3 °K the laser emitted a single mode of about 25 μW power. The pressure-tunable PbSe laser was used in the determination of the transmission spectra of Ge standards with a resolution of $10^{-2} cm^{-1}$.

1211 Injection heterolaser based on InGaAsSb four-component solid solution. Dolginov, L.M.; Druzhinina, L.V.; Eliseev, P.G.; Lapshin, A.N.; Mil'vidskii, M.G.; Sverdlov, B.N. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 416(Mar 1978).

Stimulated emission was obtained at the wavelength of 1.9 μ from a GaSb/InGaAsSb/GaSb heterostructure using an injection current of 900 A/cm^2 density at 90° K.

1212 Simple and reliable axial mode selector for a laser with active Q-switching. Sukhareva, L.K. *Sov. J. Opt. Technol. (Engl. Transl.);* **45**: No. 1, 55-56(Jan 1978).

A mode selector with electron-beam evaporated coatings was tested for a neodymium-activated glass laser. The spectrum was recorded with a Fabry-Perot etalon.(AIP)

1213 Experimental investigation of the possibility of constructing a cw electron-beam-excited recombination laser. Snezhkin, E.N.; Nezlin, M.V. *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 928-936(Nov 1977).

A report is given of a systematic experimental investigation of the possibility of constructing an electron-beam-excited laser in which the upper active level is filled as a result of recombination of a supercooled stationary plasma and the lower level is depopulated by ionization of an impurity gas [L. I. Gudzenko, M. V. Nezlin, and S. I. Yakovlenko, Sov. Phys. Tech. Phys. 18, 1218 (1974)]. The presentation of the experimental data is preceded by an analysis of a laser system differing from other treatment of the same subject [L. I. Gudzenko, M. V. Nezlin, and S. I. Yakovlenko, ibid.; Yu. I. Syst'ko and S. I. Yakovlenko, Sov. J. Quantum Electron. 5, 364 (1975); L. I. Gudzenko, L. A. Shelepin, and S. I. Yakovlenko, Sov. Phys. Usp. 17, 848 (1975)] by complete and correct allowance for the principal elementary proceses and by solution of the self-consistent problem. Systematic experiments give a clear negative result. The fundamental correctness of this result is demonstrated. A comparison is made of the present results with the calculations carried out by other authors. The reported experiments have been made possible by the generation [S. V. Antipov, M. V. Nezlin, E. N. Snezhkin, and A. S. Trubnikov, Sov. Phys. JETP 38, 931 (1974); E. N. Snezhkin and M. V. Nezlin, Sov. Phys. JETP 46, No. 3 (1977)] of a quasistationary supercooled "beam" plasma with an electron temperature T/sub e/ < or ≈0.2 eV, helium plasma density N/sub e/ > $10^{14} cm^{-3}$ and helium—hydrogen mixture concentration $N_0 = 10^{18}—10^{19} cm^{-3}$.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 583, 603, 683, 684, 692, 757, 775, 1151, 1235

1214 (DLR-FB—77-16) **Contributions TO THE TRANSPORT PHENOMENA IN FLUID MECHANICS AND RELATED FIELDS.** (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.)). 1977. 308p. (In German). Dep. NTIS (US Sales Only). EURP 14/MF A01.

Separate papers were abstracted individually.

1215 (SAND—77-1332) **COYOTE: a finite element computer program for nonlinear heat conduction problems.** Gartling, D.K. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 110p. Dep. NTIS, PC A06/MF A01.

COYOTE is a finite element computer program designed for the solution of two-dimensional, nonlinear heat conduction problems. The theoretical and mathematical basis used to develop the code is described. Program capabilities and complete user instructions are presented. Several example problems are described in detail to demonstrate the use of the program.

1216 (UCRL—52534) **Droplet phase characteristics in liquid-dominated steam—water nozzle flow.** Alger, T.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Aug 1978. Contract W-7405-ENG-48. 254p. Dep. NTIS, PC A12/MF A01.

Thesis.

An experimental study was undertaken to determine the droplet size distribution, the droplet spatial distribution and the mean droplet velocity in low-quality, steam-water flow from a rectangular cross-section, converging-diverging nozzle. A unique forward light scattering technique was developed for droplet size distribution measurements. Droplet spatial variations were investigated using light transmission measurements, and droplet velocities were measured with a laser-Doppler velocimeter (LDV) system incorporating a confocal Fabry-Perot interferometer. Nozzle throat radius of curvature and height were varied to investigte their effects on droplet size. Droplet size distribution measurements yielded a nominal Sauter mean droplet diameter of 1.7 μm and a nominal mass-mean droplet diameter of 2.4 μm. Neither the throat radius of curvature nor the throat height were found to have a significant effect upon the nozzle exit droplet size. The light transmission and LDV measurement results confirmed both the droplet size measurements and

demonstrated high spatial uniformity of the droplet phase within the nozzle jet flow. One-dimensional numerical calculations indicated that both the dynamic breakup (thermal equilibrium based on a critical Weber number of 6.0) and the boiling breakup (thermal nonequilibrium based on average droplet temperature) models predicted droplet diameters on the order of 7.5 μm, which are approximately equal to the maximum stable droplet diameters within the nozzle jet flow.

1217 Free convection across inclined air layers with one surface V-corrugated. ElSherbiny, S.M.; Hollands, K.G.T.; Raithby, G.D. (Department of Mechanical Engineering, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1). *J. Heat Transfer;* **100**: No. 3, 410-415(Jul 1978).

Experimental measurements are presented for free convective heat transfer across incline air layers, heated from below, and bounded by one V-corrugated plate and one flat plate. The measurements covered three values for the ratio, A, (average plate spacing to V-height), namely, A=1,2.5 and 4. It also covered angles of inclination with respect to the horizontal, θ, of 0,30,45 and 60 deg, and a range in Rayleigh number of $10<Ra<4 \times 10^6$. The study proves, both theoretically and experimentally, that the free convective heat transfer is essentially the same, regardless of whether the V-corrugated plate is above or below. It was found that for the same average plate spacing, L, the convective heat losses across air layers bounded by one V-corrugated and one flat plate are greater than those for two parallel flat plates by up to 50 percent for the range studied. Experimental results are given as plots of Nusselt number versus Rayleigh number. A correlation equation is given for Nusselt number, Nu, as a function of A,θ and Ra.

1218 Correlation equations for turbulent thermal convection in a horizontal fluid layer heated internally and from below. Cheung, F.B. (Reactor Analysis Safety Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Ill. 60439). *J. Heat Transfer;* **100**: No. 3, 416-422(Jul 1978).

High Rayleigh number thermal convection in a horizontal fluid layer with uniform volumetric energy sources and a constant rate of bottom heating is studied analytically by a simple boundary layer approach. Heat transfer characteristics of the layer are defined in terms of local boundary-layer variables. Correlation equations are derived for the upper and the lower surface Nusselt numbers as functions of two independent Rayleigh numbers, based respectively on the surface to surface temperature difference and the volumetric heating rate. Variation of the turbulent core temperature, which so far has not been determined successfully by existing analytical methods, is obtained. This is found to depend on a single dimensionless parameter which measures the relative rates of internal and external heating. Results of this study are presented with available experimental data.

1219 Multi-dimensional radiative transfer in nongray gases—General formulation and the bulk radiative exchange approximation. Tsai, S.S.; Chan, S.H. (Department of Nuclear Energy, Brookhaven National Laboratory, Upton, N. Y. 11973). *J. Heat Transfer;* **100**: No. 3, 486-491(Jul 1978).

The present paper presents a general formulation of the radiative heat flux and its divergence for multi-dimensional radiative problems involving nongray absorbing-emitting gases. The expressions obtained are in terms of total band absorptance rather than the spectral absorption coefficient. Thus the frequency integration is eliminated, and the expressions are more compact. They avoid the necessity of detailed spectral absorption coefficient data for radiative transfer computations. Also presented is the bulk radiative exchange approximation together with its refinement. It is proposed to circumvent the mathematical complexity inherently imbedded in nongray multidimensional problems. The approximation, which is valid in the opticlly thin and thick limits, is found to be general and useful, not only because its simplicity, but also because of its accuracy in all optical conditions.

1220 Heat transfer during piston compression. Nikanjam, M.; Greif, R. (University of California, Berkeley Department of Mechanical Engineering and Lawrence Berkeley Laboratory, Berkeley, California 94720). *J. Heat Transfer;* **100**: No. 3, 527-530(Jul 1978).

An experimental and theoretical study has been carried out to determine the unsteady heat transfer from a nonreacting gas to the end wall of a channel during the piston compression of a single stroke. A thin platinum film resistance thermometer records the surface temperature of the wall during the compression. A conduction analysis in the wall, subject to the measured surface temperature variation, then yields the unsteady heat flux. A separate analysis based on the solution of the laminar boundary layer equations in the gas provides an independent determination of the heat flux. The two results are shown to be in good agreement. This is true for measurements that were made in air and in argon. Results for the heat transfer coefficient as a function of time are also presented and exhibit a nonmonotonic variation.

1221 Numerical simulation of three-dimensional flow past bluff bodies. Hirt, C.W.; Ramshaw, J.D.; Stein, L.R. (Los Alamos Scientific Lab., NM). *Comput. Methods Appl. Mech. Eng.;* **14**: No. 1, 93-124(Apr 1978).

An improved understanding of the aerodynamics of bluff bodies, such as buildings and road vehicles, can lead to significant reductions in wind damage and gasoline consumption and to the increased safety and comfort of human occupants. To achieve this goal, improved theoretical and experimental techniques are urgently needed. This paper explores in a general way the potential of using numerical simulation methods for predicting and interpreting aerodynamic phenomena affecting bluff bodies. As a basis for discussion a prototype finite difference method is described and illustrated with sample calculations of air flow about simple bluff bodies. The limitations of this scheme are then discussed in detail, together with some suggestions for extensions that could be realized in the immediate future. The paper concludes with speculations on what could be achieved in the next five to ten years to produce a generally useful research tool for bluff body aerodynamics.

1222 (NP-tr—2015) **Isentropic expansion of water, water and steam mixtures and saturated steam.** Vetter, G. Translated from *Allg. Waermetech.;* **11**: No. 7, 119-124(1963). 15p. British Library Lending Div., Yorkshire, Eng.

Previous investigations into the isentropic expansion of water with different thermodynamic states have been mainly concerned only with the boiling water and saturated steam regions. This paper deals with the entire field in question—comprising boiling water, wet steam and saturated steam—in the pressure range from 0.4 atm to the critical pressure. Diagrams are included which permit easy determination of the throughflow quantity and critical pressure ratio with isentropic expansion of water in short nozzles for virtually all conceivable cases.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 544, 644, 1282

1223 (ANL/MSD—78-6) **Nondestructive evaluation techniques for high-temperature ceramic components. Third quarterly report, April—June 1978.** (Argonne National Lab., IL (USA)). Jun 1978. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

The overall objective of the ceramic nondestructive evaluation (NDE) program is to assess and develop NDE procedures for high-temperature ceramic components. Ceramic components are lighter than metallic components, can operate at high temperatures, and can be fabricated from inexpensive and abundant elements. Although previous work in this program has been on ceramic rotors, the current effort emphasizes ceramic heat-exchanger tubes. Ceramic heat exchangers would be useful in coal-fired Brayton conversion or waste heat-recovery systems. In the current NDE effort, several acoustic, optical, and radiographic techniques are under investigation for their effectiveness in testing ceramic heat-exchanger tubing. Progress on fracture mechanics analysis for ceramic tubing, as well as progress in the application of ultrasonic, acoustic-microscopy, dye-enhanced radiography, and infrared techniques to flaw detection in silicon carbide heat-exchanger tubing are reviewed.

1224 (LA-UR—78-1512) **Status of flash radiography in the USA today and future possibilities.** Bryant, L.E. Jr. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 5p. (CONF-780804—4). Dep. NTIS, PC A02/MF A01.

From 13. congress on high-speed photography and photonics; Tokyo, Japan (20 Aug 1978).

A listing of presently employed flash x-ray generators is given including low-energy, commercially available systems and high-energy very specialized installations in government laboratories. These flash x-ray sources are compared as to radiographic characteristics. Imaging techniques and materials are surveyed and compared as to their advantages and limitations. A variety of applications of flash radiography are cited including explosive, ballistic, diffraction, crash injury, and fuel injection. Probable near term advances in special techniques are mentioned in cine radiography and film image enhancement. Possible future developments are speculated upon such as flash radiographic applications of computerized axial tomography. The recent recognition of flash radiography at professional society conferences is reviewed.

1225 (UCID—17877) **Formation and transport of a bright electron beam for flash x-ray applications.** Kulke, B.; McFarlane, H.B.; Kihara, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1978. Contract W-7405-ENG-48. 29p. Dep. NTIS, PC A03/MF A01.

Measurements have been carried out to characterize a 1 MeV, 1 to 5 kA field emitter diode and to determine the emittance of the electron beam generated. The diode was found to be approximately

space charge limited, and the beam emittance at 300 to 500 A of collimated beam was measured at 30 π to 70 π mr-cm, depending on the emitter geometry. Simple confinement of the beam over a one meter distance also was demonstrated, using axial magnetic confining fields of less than one kilogauss.

1226 Modern trends in isotope neutron radiography. Dande, Y.D. (BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA). NUCLEAR PHYSICS DIV.). pp 359-370 of Proceedings of the national symposium on industrial isotope radiography. Bombay; Department of Atomic Energy (1977).

From National symposium on industrial isotope radiography; Tiruchirapalli, India (26 Feb 1976).

A brief description of the Apsara neutron radiography facility set up at the Bhabha Atomic Research Centre, Bombay, is given. An account of some typical problems successfully tackled with the use of this facility is presented. The problems involved examination of : (1) presence of water in marker shells, (2) tetranitromethylaniline charge in electric detonators, (3) PETN charge in flexible linear shaped cards and (4) boron distribution in boral composites meant for use in neutron shielding.

1227 Radiography and radiometry to analyse plant problems at Hindustan Petroleum Refinery. Rebello, H.J. (HINDUSTAN PETROLEUM CORP. LTD., BOMBAY (INDIA)). pp 138-154 of Proceedings of the national symposium on industrial isotope radiography. Bombay; Department of Atomic Energy (1977).

From National symposium on industrial isotope radiography; Tiruchirapalli, India (26 Feb 1976).

Some of the techniques of radiography and radiometry used to successfully solve several operating problems at the Hindustan Petroleum Refinery at Bombay, have been reviewed. Radiography has been used to determine pipe wall thickness, check plugging of pipelines and dropped seats in valves, and establish tray positions in fractionating towers. Radiometry (the gamma rays absorption technique) has been used for solving several process engineering problems. It has been used to determine densities in catalyst U-bends, check plugging in pipelines, confirm suspected tray dislodgements in distillation towers and check for leakage in tanks.

ELECTRONIC CIRCUITS AND DEVICES

1228 (SAND—77-2022) **Thermoxidative stability of various natural and synthetic waxes used in the processing of hybrid microcircuits.** Wagner, J.A.; Arnold, C. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 33p. Dep. NTIS, PC A03/MF A01.

Bonding problems associated with the incorporation of beam leaded devices (BLD's) into hybrid microcircuits were traced to the presence of degraded wax on the "feet" of the BLD's. No information was available on the composition or stability of these natural waxes which are used to secure the BLD's during etching, shipment and storage. In this study the composition and thermoxidative stability of three commercial natural waxes were determined. It was found that oxidation can occur at temperatures of 100°C; at high temperatures (150°C) the waxes are converted to insoluble chars. Vaseline, which is used as an additive to facilitate the removal of the larger BLD's from the storage plates, had no effect on the stability of the waxes. Waxes made from poly(chlorotrifluoroethylene) were stable toward thermoxidation under the conditions used to process BLD's and are recommended as replacements for the natural waxes. 13 figures.

1229 (SAND—78-1524) **Routing algorithms for integrated circuit design.** Wada, M.M. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 61p. Dep. NTIS, PC A04/MF A01.

Routing algorithms for integrated circuit design are surveyed. The characteristics of each algorithm are summarized, and the advantages or disadvantages of using the algorithm for specific applications are noted. 37 figures, 4 tables.

WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 943

1230 (CONF-780549—5) **Pilot plant demonstration of an anaerobic fixed-film bioreactor for wastewater treatment.** Genung, R.K.; Million, D.L.; Hancher, C.W.; Pitt, W.W. Jr. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 19p. Dep. NTIS, PC A02/MF A01.

From Symposium on biotechnology in energy production; Gatlinburg, TN, USA (10 May 1978).

The design, operation, performance, and economics of alternatives to the anaerobic upflow (ANFLOW) bioreactor for treating waste waters and for providing some waste gasification and solids removal are described. Based on progress to date, it is obvious that significant treatment of dilute wastewaters at low temperatures can be obtained with an upflow, anaerobic, fixed-film bioreactor as demonstrated by the ORNL pilot plant. The bioreactor performance is stable after 16 months of operation and has been shown to be relatively insensitive to ambient temperature changes. Sludge removal requirements are still under evaluation, but preliminary indications suggest that the rate of biomass accumulation in the column is slow. The quality of the effluent produced by the pilot plant at the present stage of development indicates the need for a polishing step; a physical method such as sand filtration will probably be adequate. The overall performance of the bioreactor can probably be improved with better designs for mechanical flow distributors. Gas production rates have not been defined as yet due to mechanical difficulties in sealing the large-scale unit, but rates in excess of 100 liters/day have been observed with methane contents as high as 70%. These rates are still under investigation. A preliminary economic evaluation shows that the ORNL ANFLOW process is competitive at plant capacities of 1 mgd or less. The savings are primarily related to operating costs but occur in capital costs as well.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 31, 162, 163, 168, 171, 537, 538, 555

1231 (HCP/T1237—02/1) **Multicell fluidized bed boiler design, construction, and test program. Interim report, July 1976—June 1977.** Mesko, J.E.; Leon, I.W.; Reed, R.R.; Gray, C.; Gamble, R.L.; Malik, J. (Pope, Evans and Robbins, Inc., New York (USA)). Jul 1978. Contract EX-76-C-01-1237. 226p. (FE—1237-4). Dep. NTIS, MF A01.

Portions of document are illegible.

Design, construction and test program of a 300,000 lb/hr steam generating capacity multicell fluidized-bed boiler (MFB), as a pollution-free method of burning high-sulfur or highly corrosive coals, is being carried out. The concept involves burning fuels, such as coal, in a fluidized-bed of limestone particles that react with the sulfur compounds formed during combustion, to reduce air pollution. Nitrogen oxide emissions are also reduced at the lower combustion temperatures. The $CaSO_4$ produced in the furnace is discharged with the ash, or regenerated to CaO for reuse in the fluidized-bed. This report presents information on start-up and sustained operation of the Rivesville MFB steam generating plant, identification and analysis of operational problems and corrective action to improve performance and reliability; studies and tests to develop and evaluate alternate MFB light-off techniques, fly ash reinjection and alternate fuel feed systems; construction completion and preparation of operation manuals.

1232 (HCP/T2473—21, pp Pt. I, 105p) **Evaluation of cold flow testing for industrial application of fluidized bed combustion. Final report for period, July 1977—October 1977.** Bauver, W.P. II; Bianca, J.D.; Kantesaria, P.P.; Matthews, F.T. (Combustion Engineering, Inc., Windsor, CT). Jul 1978.

In Industrial application of fluidized bed combustion. Phase I. Quarterly technical progress report for the period, January—March 1978.

To aid in the design of the demonstration unit, a hot sub-scale unit (SSU) simulating a module of the demonstration unit is being built and tested. This unit will provide information on combustion rates and limestone utilization, bed performance, heat transfer rates and coolant flow distribution. Cold flow modeling was used to supply information needed in the design of the SSU and the demonstration unit. A two-dimensional (28 x 2 in.) model was used to study bubble characteristics and to screen distributor plates. A three-dimensional full scale model of the SSU was also built and tested. This model was used to study bed dynamics, bed and plate pressure drops, as a function of various air distributor plates and immersed tube bundles. The model was tested with beds of 1/4 in. top-size and 1/8 in. top-size limestone similar to that which will be used in the SSU. This report describes the cold flow modeling program and presents the results, conclusions, and recommendations obtained. An important characteristic of fluidized beds, that must be known if successful scaling is to be achieved, is the determination of what flow regime the bed will be in, bubbling, slugging, turbulent, etc. In order to assess the behavior of 3-D beds at the onset of slugging, two methods were used to establish the presence of slug flow. The first method involved observing the bed height fluctuations visually. The second method involved measuring the magnitude of pressure fluctuations. Pressure fluctuations of the order of 5 to 10 percent (or

greater) of the pressure drop through the bed were assumed to indicate the point of incipient slugging.

1233 (HCP/T2473—21, pp Pt. II, 48p) **Evaluation of slumped bed testing for industrial application of fluidized bed combustion. Final report for period, July 1977—October 1977.** Bauver, W.P. II; Bianca, J.D.; Jones, B.C.; Matthews, F.T. (Combustion Engineering, Inc., Windsor, CT). Jul 1978.

In Industrial application of fluidized bed combustion. Phase I. Quarterly technical progress report for the period, January—March 1978.

Turndown and load control pose a problem to the designer and user of fluidized bed boilers. It is difficult to maintain good fluidization over the wide range of air flow rates necessary for combustion control. One method being considered as a means of turndown and load control is defluidization and refluidization of discrete bed sections. Fluidization and ignition of successive bed sections will be used to start up the demonstration unit. There is little information available on slumping (defluidizing) or refluidizing a section of bed adjacent to other sections which may be either slumped or fluidized. In support of the demonstration unit design, C-E performed cold flow model tests to determine the feasibility of defluidizing and refluidizing discrete sections of a fluidized bed. Information on the following was obtained: active and slumped bed surface profiles as a function of time; active bed pressure drop as a function of time; slumped/active bed interface geometry; air pressure fluctuations below the distributor plate when refluidizing slumped bed sections; and overall material transfers from active to slumped bed sections. This report presents a description of the experimental procedures, results, and conclusions of the slumped bed test program. An analytic evaluation is presented which relates slumped bed dynamics to the observed experimental results.

1234 (HCP/T2473—21, pp Pt. III, 23p) **Four way stream splitter test.** Jul 1978.

In Industrial application of fluidized bed combustion. Phase I. Quarterly technical progress report for the period, January—March 1978.

In an effort to design a feed system for fluid bed boilers, Fuller Company proposed the use of the Fuller Kinyon pump to inject the 1/4" x 0 coal into a pressure conveying stream. This single stream will be split into a number of individual conveying streams, each which will have essentially the same coal and air distribution. Each of the lines will terminate at a different point on the fluid bed boiler, supplying the mixture of coal and limestone to the bed. Since this approach had been tested by Fuller Company for application to conveying of pulverized materials (70 percent -200 mesh) the purpose of this test and demonstration was initially to show the operation of the splitter on the coarse material. As the project continued, the subject of moisture of the coal became an important addition, and tests were conducted with coal up to a total moisture of 19 percent. Sufficient work was accomplished to show that the maximum moisture of the mix of coal and limestone should not exceed 6.0 percent for completely trouble free operation. Below this moisture the feed of the mixture into the pump, conveying line, stream splitter, and eventual hoppers was conducted without any material hang-up or bridging. It is probable that a higher moisture could be tolerated with a larger size F-K Pump and a greater pressure drop through the splitter. The stream splitter requires a mechanical distribution of the material and then sufficient air restriction to force the air flow through any line configuration without plugging of any one of the lines. This is accomplished through the adjusting of the restriction in the stream splitter.

1235 (SVF—44) **Heat transfer from flames to the surrounding walls.** Stroemberg, L. (Stiftelsen foer Vaermeteknisk Forskning, Studsvik (Sweden)). Jun 1977. 109p. Dep. NTIS (US Sales Only), PC A06/MF A01.

A new mathematical model of the heat transfer process from a flame to the surrounding walls is described. The model is fully three dimensional and any shape of the combustion chamber can be treated. The aim of the work was to obtain a method of calculation which will be useful, and therefore, of simple nature. The model is based on a calculation of the radiative heat transfer from a flame to a wall. This calculation is performed in a new and time-saving manner. The calculation uses information which is empirically known or calculated. The model is applied to several empirically verified examples, and some of the results obtainable with the models are presented. A complete calculation example of a box-shaped oil-fired furnace is presented, including a complete computer program. A simple useful method of determining the local heat fluxes on the walls of the combustion chamber is the result. As a spin-off an insight in certain technically important phenomenon concerning the nature of the heat transfer in furnaces is achieved. It is shown for example that the shape and size of the luminous flame affect the heat transfer process considerably.

UNDERGROUND ENGINEERING

REFER ALSO TO CITATION(S) 136, 158, 823, 833, 836

1236 **Pneumatic conveying development.** Tweedy, D.H. (Radmard Eng Ltd, Vancouver, BC). *Min. Eng. (London);* **137**: No. 201, 501-509(Apr 1978).

A brief outline is presented of current methods applied in pneumatic conveying, with special emphasis on low pressure operation; various types of infeed media are noted. The author then develops the subject of current applications, most of which are, at present, operating under field trial conditions, approaching start-up or have been commissioned since 1970. Installations are described covering backfill operations applied to metal mining in the United States of America and in the Republic of South Africa; research into a tunnel dirt-disposal system at the Colorado School of Mines; and finally, to the application of pneumatic conveying to the hoisting of minerals in Great Britain.

1237 **New developments in shaped charge technology.** Carter, W.J. (Los Alamos Sci Lab, NM). *Pet. Eng.;* **50**: No. 4, 24, 26, 30, 32, 34(Apr 1978).

The author briefly discusses the historical development and refinement of shaped charges as explosively driven perforator devices and explains the purpose of these devices. Although consideration of such devices for use in downhole environments is only beginning, their potential appears so great as to warrant a description and status report at this development stage. Special emphasis is placed on highly penetrating jets, and the parameters governing the jet performance are discussed in detail. Potential applications of these directional, highly penetrating devices are also discussed. 3 refs.

1238 **Current use of chemicals as fire-retardants for mine timber.** Hawkins, F.A. (Chamber of Mines Res Organ, Metall Lab, S Afr). *J. Mine Vent. Soc. S. Afr.;* **31**: No. 3, 41-46(Mar 1978).

A review of the inorganic and organic chemicals that are in current use as fire-retardants for mine timber is outlined. The results of selected tests of ammonium salts used as impregnants by the National Coal Board of Great Britain are described and the advantages and disadvantages of using this type of treatment are discussed. 14 refs.

1239 **Completion of tunnel through landslide deposit: a key element in Bonneville second powerhouse project.** MacDonald, R.D. *Tunn. Technol. Newsl.;* No. 21, 1-4(Mar 1978).

The design, geologic considerations and construction of a 1545 ft long single-track railroad tunnel through an ancient landslide deposit near the Bonneville second power house are described. (LCL)

1240 **Steering of mining machines.** Hartley, D. (to Coal Industry (Patents) Ltd.). US Patent 4,072,349. 7 Feb 1978. Priority date 7 Dec 1973, United Kingdom of Great Britain and Northern Ireland (UK). 4p.

A mineral mining machine which wins a strip of mineral by separate roof and floor cutting stages comprises steering apparatus which senses the cutting horizon associated with one cutting stage to control the cutting horizon associated with the other cutting stage.

1241 **Method for mining of rock or ore according to the block caving principle in massive formations.** Janelid, E.I. US Patent 4,072,352. 7 Feb 1978. Priority date 20 Aug 1974, Sweden. 6p.

There is provided a method for extraction of rock or ore according to the block caving principle comprising driving, at several levels, principally straight, parallel and horizontal drifts into the lower part of a block, choosing the distance between the drifts at each level so that remaining supporting pillars will cover at least 40% of the block area, undercutting the block from the drifts in such a way that the drift openings toward the undercut area and the drift coverings will be arranged in steps, the drift openings being utilized as draw-points for the caving material and the number of drift levels being chosen with regard to desired horizontal distance along the direction of the drift between the draw-points at adjacent levels.

1242 **Crawler sliding hydraulic roof support.** *Aust. Min.;* **70**: No. 2, 47, 52(Feb 1978).

The crawler sliding hydraulic roof support has been tested in France. It is capable of staying permanently tightened between roof and floor. It is set in motion by sliding on crawlers, with its legs under the load.

MARINE ENGINEERING

1243 (CONF-780825—P3, pp H1.1-H1.5) **Department of Energy/fossil energy/drilling and offshore technology.** Guier, D.F.; Ferrero, E.P. (Dept. of Energy, Washington, DC). 1978.

From 4. symposium on enhanced oil and gas recovery and improved drilling methods; Tulsa, OK, USA (29 Aug 1978).

In Fourth DOE symposium on enhanced oil and gas recovery and improved drilling methods. Vol. 2.

The Department of Energy Drilling and Offshore Technology activities have and will be focused on: (1) accelerating and successfully implementing offshore oil and gas technology in OCS areas; (2) mobilizing the nation's technology to supply a sufficient share of the nation's energy needs by 1985; (3) providing viable alternatives and solutions to socio-economic, environmental, and ecological problems associated with offshore drilling and production; (4) functioning as a catalyst to resolve societal, jurisdictional, and regulatory conflicts that impede resource development; and (5) cost-share RD and D programs and projects with Federal agencies, industry, and universities. Studies currently being conducted under drilling and offshore technology include: drilling, offshore technology, and environment and support. DOE activities in these areas are summarized.

1244 (SAND—78-0095C) **Development of a Seafloor Earthquake Measurement System.** Ryerson, D.E.; Reece, E.W. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 4p. (CONF-780909—1). Dep. NTIS, PC A02/MF A01.

From OCEANS; Washington, DC, USA (6 Sep 1978).

A Seafloor Earthquake Measurement System is being developed at Sandia to measure marine sediment response to seismic activity. The system will use an acoustic telemetry system to transmit commands to and collect data from the seafloor package. The seafloor package contains a microprocessor which controls the data collection, data processing, and acoustic telemetry. A one million bit magnetic bubble memory is used for storage of seismic data obtained from a three-axis accelerometer package. The microprocessor continuously compares the incoming data in mass memory and saves the "best" data for later readout by the acoustic telemetry system. The seafloor package consists of a ballast emplaced pressure vessel and probe containing the accelerometer. After the probe is inserted into the sediment, the ballast weight is removed and a section of the probe is retracted to mechanically isolate the accelerometers.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 129, 564, 565

1245 **Method for removing hydrogen sulfide.** Fukuda, Y.; Ihida, M.; Kawai, Y. (to Nippon Kokan Kabushiki Kaisha). US Patent 4,038,366. 26 Jul 1977. Priority date 29 Jun 1974, Japan. 8p.

A method for removing hydrogen sulfide from a hydrogen sulfide entrained gas comprises the steps of bringing the hydrogen sulfide entrained gas into contact with an alkaline absorption solution with a pH of 10 to 14 to cause hydrogen sulfide in the gas to be absorbed into an alkaline absorption solution, subjecting the resultant absorption solution to a DC electrolytic treatment whereby an alkaline solution is separated into a cathode chamber and sulfur and sulfuric acid are separated into an anode chamber, and circulating as the alkaline absorption solution the alkaline solution produced within the cathode chamber. This constitutes a closed system, thereby completely eliminating a cause for public nuisance.

1246 **Apparatus for separating particles from a gas stream.** Guttmann, F.W. (to Klockner-Humboldt-Deutz AG). US Patent 4,036,612. 19 Jul 1977. Priority date 17 May 1975, German, Federal Republic of (F.R. Germany). 6p.

Apparatus for separating solid substances from a stream of gas employing vertical deflecting plates extending parallel to one another but arranged inclined to the direction of gas flow. The deflecting plates are provided with open collecting grooves and with a fluidizing layer of gas on the outer surfaces thereof.

1247 **Process for the removal of hydrogen sulfide and mercaptans from liquid and gaseous streams.** Sibeud, J.P.; Ruff, C.D. (to Rhodia, Inc.). US Patent 4,036,942. 19 Jul 1977. Filed date 22 Jan 1973. 22p.

A process is provided for removing hydrogen sulfide and alkyl mercaptans from fluid streams by reaction with oxygen in the presence of a metal amino acid chelate in aqueous solution containing an amine, converting hydrogen sulfide to sulfur and alkyl mercaptans to dialkyl disulfides, and separating these from the aqueous metal chelate solution. A process is also provided for removing hydrogen sulfide and alkyl mercaptans from fluid streams in which the gaseous or liquid stream is dispersed in aqueous metal chelate solution in a fine dispersion short of foam formation and passed through a reaction zone at a high flow velocity, where hydrogen sulfide is catalytically oxidized to sulfur, and alkyl mercaptans to dialkyl disulfides, and then into a relatively wide quiescent zone where the dispersion breaks, the gases are separated, and the metal chelate solution recovered.

1248 **Process for the purification of industrial effluents.** Wegmueller, H.; Haase, J. (to Ciba-Geigy Corp.). US Patent 4,026,796. 31 May 1977. Priority date 10 May 1973, Switzerland. 16p.

A novel process for purifying industrial effluents which comprises bringing said effluents into contact with cellulosic absorbent which has been pretreated with precipitants. The process is used especially for decolorization of waste liquors arising in the textile, paper, and leather industries.

1249 **Methods of purifying gas containing nitrogen oxide, and compositions used therefor.** Shibata, T.; Maki, M.; Suzuki, M.; Kawabe, H. (to Matsushita Electric Industrial Co., Ltd.). US Patent 4,025,603. 24 May 1977. Priority date 19 Oct 1973, Japan. 14p.

In removing nitrogen oxide from a gas containing it, the gas is passed through a region where at least one of calcium sulfate and calcium hydroxide coexists with powerful oxidation agents such as sodium chlorite, potassium permanganate, etc. thereby removing the nitrogen oxide, mainly nitrogen monoxide, from the gas. This method is very effective in purifying exhaust gases resulting from burning operations, since 80 to 90 percent or more of the nitrogen oxide contained in the exhaust gases is nitrogen monoxide. In addition, this method is also effective in purifying indoor air.

1250 **Method for the removal of dust from exhaust gases.** Ritzmann, H.; Wohlfarth, J.P. (to Polysius AG). US Patent 3,989,482. 2 Nov 1976. Priority date 11 Jun 1971, German, Federal Republic of (F.R. Germany). 4p.

A stream of raw material is passed through a preheater to a furnace and a stream of exhaust gases from the furnace is passed through the preheater to preheat the raw material. Dust is electrostatically precipitated from the exhaust gases leaving the preheater, and the temperature of such exhaust gases is controllably raised to improve the efficiency of the dust removal by bypassing a controlled proportion of at least one of the streams around at least a portion of the preheater.

BRAYTON

REFER ALSO TO CITATION(S) 435

RANKINE

REFER ALSO TO CITATION(S) 435

PARTICLE ACCELERATORS

1251 **History of a "user" publication.** Wildensten, M.V. (Lawrence Berkely Lab., CA). *Tech. Commun. (Wash., D.C.);* 17-19(1977).

In 1969 a small monthly report was initiated at the Lawrence Berkeley Laboratory to provide current information on accelerator operations and noteworthy research events in high-energy physics. The article relates how this information vehicle grew into a much larger research status report called Research/Accelerators according to the changing needs of the scientists and engineers and the changing character of the research programs. From its small beginnings as a handy source of current information, the report has now grown into an important communications medium for the laboratory.

AUXILIARIES AND COMPONENTS

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 1263

1252 (LA—7274-MS) **Feasibility study of a nonlinear servo-collimator position control system by means of analog computer.** Liska, D.J. (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 18p. Dep. NTIS, PC A02/MF A01.

A biomedical application for a servo-controlled multijaw collimator exists at LAMPF in which the collimator provides transverse control over the beam spot size in conjunction with longitudinal control of penetration depth from the range shifter. A linear position servo is the obvious choice, but design constraints and the physical hardware required introduce numerous nonlinear and quasi-nonlinear effects. A simulation by analog computer of one degree of

freedom has provided enough information to conclude that the preliminary design concept is feasible, even in the presence of nonlinear friction and amplifier saturation, if the drive belt is sufficiently stiff.

STORAGE RINGS

1253 (BNL—50865) **Vertical dispersion correction.** Parzen, G. (Brookhaven National Lab., Upton, NY (USA)). 30 Jun 1978. Contract EY-76-C-02-0016. 7p. Dep. NTIS, PC A02/MF A01.

A method for correcting the vertical dispersion is proposed in which the vertical closed orbit is primarily displaced at locations where the sextupole chromaticity correctors are placed in order to generate the skew quadrupole fields needed to correct the vertical dispersion. The results of a computer simulation study indicate that this method is feasible for ISABELLE, where a maximum displacement of the vertical closed orbit of about 2.0 mm is required.

1254 (DOE/EIS—0003) **Final environmental impact statement. Proton—Proton Storage Accelerator Facility (ISABELLE), Brookhaven National Laboratory, Upton, New York.** (Department of Energy, Washington, DC (USA)). Aug 1978. 88p. Dep. NTIS, PC E03/MF E03.

An Environmental Impact Statement for a proposed research facility (ISABELLE) to be built at Brookhaven National Laboratory (BNL) is presented. It was prepared by the Department of Energy (DOE) following guidelines issued for such analyses. In keeping with DOE policy, this statement presents a concise and issues-oriented analysis of the significant environmental effects associated with the proposed action. ISABELLE is a proposed physics research facility where beams of protons collide providing opportunities to study high energy interactions. The facility would provide two interlaced storage ring proton accelerators, each with an energy up to 400 GeV intersecting in six experimental areas. The rings are contained in a tunnel with a circumference of 3.8 km (2.3 mi). The facility will occupy 250 ha (625 acres) in the NW corner of the existing BNL site. A draft Environmental Impact Statement for this proposed facility was issued for public review and comment by DOE on February 21, 1978. The principal areas of concern expressed were in the areas of radiological impacts and preservation of cultural values. After consideration of these comments, appropriate actions were taken and the text of the statement has been amended to reflect the comments. The text was annotated to indicate the origin of the comment. The Appendices contain a glossary of terms and listings of metric prefixes and conversions and symbols and abbreviations.

1255 (SLAC-PUB—2150) **Picosecond phase shift measurements at 358 MHz using synchrotron radiation.** Sabersky, A.P.; Munro, I.H. (Stanford Linear Accelerator Center, CA (USA); Stanford Univ., CA (USA). School of Medicine). Jul 1978. Contract EY-76-S-03-0326. 5p. (CONF-780579—6). Dep. NTIS, PC A02/MF A01.

From Meeting on picosecond phenomena; Hilton Head, SC, USA (24 May 1978).

Properties of synchrotron radiation from SPEAR are reviewed. The power—frequency spectrum of source and photomultiplier tube is measured with a spectrum analyzer. The decay time of a single fluorescent species can be deduced by measuring the phase delay between excitation and fluorescence radiation modulated at a single suitable frequency. It is possible to characterize completely the time (impulse) response or the complex frequency response of a linear system with only phase measurements. A number of test experiments were made by using apparatus designed for time-resolved fluorescence emission anisotropy studies of tryptophan in proteins. Phase shifts were produced by insertion of water-filled quartz cells into the beam and by the introduction of a thick glass slab. The total optical path length could also be altered by linear motion of the phototube. The results yielded 4.7 +- 0.5 degrees per cm of motion. It was concluded that this procedure can be used to study short atomic and molecular fluorescence lifetimes. 3 figures. (RWR)

INSTRUMENTATION

1256 **Parts-per-million water vapor generating system used to simulate moisture in small integrated circuit packages.** Hartley, J.L. (Measurements Standards Laboratory Division, Sandia Laboratories, Albuquerque, New Mexico 87185). *Rev. Sci. Instrum.;* **49**: No. 12, 1647-1649(Dec 1978).

A simple, portable system has been developed and tested for generating a known water—vapor content is selected permanent gases or gas mixtures. Parts-per-million values ranging from 250 to 20 000 are generated in a continuous flowing stream at flowrates ranging from 50 to 200 cm^3/min. A known volume of the flowing gas can be selected to simulate the internal free volume and internal pressure of hermetically sealed packages as small as 0.04 cm^3. By using a variety of available connectors, the selected volume of gas may be transferred into the inlet system of a mass spectrometer for water—vapor calibration. Generator stabilizing time and upper flowrate limits are given along with test results when compared to a Transfer Humidity Standard.

1257 **New method for measuring electrical conductivities of solids in a diamond anvil cell.** Walling, P.L.B.; Ferraro, J.R. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **49**: No. 11, 1557-1558(Nov 1978).

A new method of measuring electrical conductivities of solids in a diamond anvil cell (DAC) has been developed. The dc method involves a four-point probe measurement. The method is suitable for measuring the electrical conductance of bulk (polycrystalline) solids or single crystals, as a function of temperature and/or pressure.

1258 **Optically coupled high-voltage isolation amplifier.** Pearce, J.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Rev. Sci. Instrum.;* **49**: No. 11, 1562-1564(Nov 1978).

A common and persistent problem in modern instrumentation is the observation and recording of small signal waveforms that are removed from ground by very high voltages. Examples of this are the instrumentation of neutral particle injectors used in controlled thermonuclear research and the construction of safety breaks for air core toroidal devices. To overcome this problem a very high voltage isolation amplifier was designed. It employs analog-to-digital conversion with serial data transmission on a fiber optic cable.

1259 **Comparison of synchrotron and laboratory discharge light sources.** Radler, K.; Berkowitz, J. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Opt. Soc. Am.;* **68**: No. 9, 1181-1183(Sep 1978).

A direct comparison has been made between the intensity of dispersed radiation from a laboratory Hopfield helium continuum and that obtained from the electron storage ring called Tantalus 1. The relative advantages and disadvantages of the respective light sources are described. Extrapolation of this information to other (present and future) electron storage-ring sources is discussed.

1260 **New results in the theory of a plane-mirror interferometer.** Lambert, D.K.; Richards, P.L. (Department of Physics, University of California, and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *J. Opt. Soc. Am.;* **68**: No. 8, 1124-1130(Aug 1978).

We investigate the properties of a common type of two-beam interferometer in which the recombined beams are focused onto a detector and in which the optical system acting on the separated beams is composed of plane mirrors. For an arbitrarily complicated system of plane mirrors the behavior may be analyzed in terms of the four parameters path difference, angle of tilt, lateral shear, and angle of rotary shear. Fourier spectrometers vary only path difference, while shearing interferometers vary only lateral shear. We show that from measurements of the detected interference as a function of both lateral shear and path difference one may compute the optical transfer function of the output optics as a function of both optical and spatial frequency.

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 320, 592, 608, 609, 658, 679, 680, 726, 1158, 1264, 1343, 1350, 1351, 1352, 1353, 1354, 1355, 1356, 1357, 1358, 1359

1261 (IAEA-SM—229/105) **Low cost high reliability alpha beta gamma hand and shoe monitor using multiple chamber fast response air ionization probes.** Fergus, R.W.; Robinet, M.J. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 16p. (CONF-780612—9). Dep. NTIS, PC A02/MF A01.

From Symposium on advances in radiation protection monitoring; Stockholm, Sweden (26 Jun 1978).

A hand and shoe monitor will be described which represents a significant departure from the traditional in that it utilizes air ionization probes with simple analog electronic circuitry. Two primary problems which required solution during the development of the monitor were: a probe design that would not only protect the fragile window but would also minimize electrical signals due to window vibrations caused by the user stepping on the probes and a circuit design which would shorten the long response time of a typical low level ionization chamber input amplifier. The monitor has sensitivity comparable to the presently available equipment. Its

attractive features include low initial cost and no predictable failure modes other than severe window damage by careless users. Because of the simple design, minimal expertise and facilities are required for fabrication and maintenance.

1262 (LA-UR—78-1866) **Utilization of fiber optics in radiation diagnostics.** Lyons, P.B.; Golob, J.E.; Looney, L.D.; Hocker, L.; Lutz, S.; Nelson, M.A.; Robichaud, R.E. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 8p. (CONF-780923—1). Dep. NTIS, PC A02/MF A01.

From Fiber optics and communications exposition; Chicago, IL, USA (6 Sep 1978).

Fiber optics can provide a cost effective transmission medium for wide bandwidth radiation diagnostics. Passive systems have been investigated which allow conversion of radiation energy to optical energy with direct coupling to optical fibers. Organic scintillators have been developed which emit at wavelengths near 600 nm. The new scintillators yield a FWHM below 1.5 ns. The scintillator emission band is very broad, leading to the requirement of optical filtering to limit material dispersion in the fiber. Trade-offs involving fiber length, dynamic range, fiber radiation damage, scintillator radiation damage, bandwidth, and spectral filter width are discussed.

1263 **Detection system for charged particles produced by neutrons.** Alvar, K.R.; Barschall, H.H.; Borschers, R.R. (Wisconsin Univ., Madison (USA)); Grimes, S.M.; Haight, R.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Instrum. Methods;* **148**: No. 2, 303-309(15 Jan 1978).

Systems consisting of two or three magnetic quadrupole lenses and detectors were developed for studying charged particles produced by 15 MeV neutrons. The lenses transport the charged particles from a radiator near the neutron source to the detectors located about 2.6 m away in order to reduce the neutron-induced background in the detectors.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

1264 (BNWL-SA—6301) **Evaluation of well-type Ge(Li) detectors for low-level radiochemical analysis.** Brauer, F.P.; Mitzlaff, W.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1977. Contract EY-76-C-06-1830. 22p. (CONF-771023—49). Dep. NTIS, PC A02/MF A01.

From Nuclear science symposium; San Francisco, CA, USA (19 Oct 1977).

Well-type Ge(Li) detectors have been evaluated for low-level gamma-ray spectrometry and radiochemical analyses. The detectors were found to have good resolution, high peak-to-Compton ratios and low backgrounds. The use of an anticoincidence shield further improves the detector performance. The detector efficiencies and backgrounds are compared with those obtained with other Ge(Li) detector systems. The well detectors were found to have better detection efficiencies and as low backgrounds as either large coaxial detectors or opposed detector systems. Sum-coincidence effects are more pronounced in the well detector and use of this feature is discussed. Applications which utilize the low-energy response of the detector are described. Minimum detectable activity levels were determined for several nuclides.

1265 **Novel zero time detector for heavy ion spectroscopy.** Bowman, D.J.; Heffner, R.H. (Los Alamos Scientific Lab., N.Mex. (USA)). *Nucl. Instrum. Methods;* **148**: No. 3, 503-509(1 Feb 1978).

The design, construction and test of a heavy ion time pick-off system are described. The detector presents a homogeneous foil of a few $\mu g/cm^2$ thickness to the beam. Secondary emission electrons are isochronously transported to a channel plate electron multiplier by crossed electric and magnetic fields. A time resolution of (230 +- 30) ps has been measured using natural alpha particles and a time coincidence between a surface barrier silicon detector and the foil time pick-off system. Sources of the measured time dispersion are discussed.

1266 **Method of pseudostatistical modulation in time-of-flight neutron spectroscopy.** Kroo, N.; Cher, L. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 6, 582-593(Nov 1977).

Use of the method of pseudostatistical modulation in neutron spectroscopy is reviewed. Results are given that demonstrate the effectiveness of the method.

1267 **Piezoelectric Moessbauer spectrometer with fast channel advance rates.** Forster, A.A.; Potzel, W.; Kalvius, G.M. (Technische Universitaet Muenchen, Garching, Ger.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 29-34(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

A Moessbauer spectrometer is described which uses a piezoelectric quartz drive to generate Doppler velocities for high resolution Moessbauer experiments with the 93.3 keV resonance in ^{67}Zn. The spectrometer is coupled to a PDP8e computer by an interface which initiates a read-in cycle when a nuclear pulse has been counted in the detector. The interface works free of dead time at mean count rates $<$ or $=$ to $2 \cdot 10^5 s^{-1}$ and allows channel advance frequencies up to some MHz.

1268 **Spherical electrostatic electron spectrometer for Moessbauer spectroscopy.** Benczer-Koller, N.; Kolk, B. (Rutgers—The State Univ., New Brunswick, NJ). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 107-111(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

A high transmission spherical electrostatic electron spectrometer was constructed for combined Moessbauer and conversion electron spectroscopies. To date, a transmission of 7% and an energy resolution of 2.5% at 14 keV were achieved for a source of 1 cm diameter.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 1705

1269 **Some possibilities of detecting muons and neutrinos.** Zheleznykh, I.M.; Leonov, Y.S. (Nuclear Research Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 8, 427-429(20 Apr 1978).

The possibilities are considered of deep-water muon and neutrino detectors using systems for Cerenkov-light gathering fiber optics, and semiconductor receivers.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 1311

1270 (BDX—613-1795(Rev.)) **Multilayered plating thickness. Final report.** Russell, R.J. (Bendix Corp., Kansas City, MO (USA)). Aug 1978. Contract EY-76-C-04-0613. 30p. Dep. NTIS, PC A03/MF A01.

A nondestructive technique utilizing the X-ray fluorescence spectrometer has been developed for measuring the thickness of both single and multiple layers of plating. Thickness standards and calibration curves also have been developed to support the measurements. Mathematical models for equating the intensity of the fluorescent radiation to the plating thickness are presented.

1271 (SAND—78-0245) **Laboratory evaluation of five commercial electron capture-type explosives vapor detectors.** Williams, W.D.; Sandling, L.L.; Conrad, F.J. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 57p. Dep. NTIS, PC A04/MF A01.

A laboratory evaluation of the performance and maintenance characteristics of the Elscint, Ltd Model EXD-2; Ion Track Instrument, Inc. Model 70; Leigh-Marsland, Ltd. Model S-201; Pye Dynamics, Ltd. Model PD.2.A; and the Xonics, Inc. Model GC-710 explosives vapor detectors has been conducted. Each uses an electron capture detector to determine the presence of explosives vapors. Vapor collection schemes and methods used to discriminate against possible vapor interferents are discussed. These detectors were evaluated for qualitative response to a variety of explosives and nonexplosives vapors. The results of a quantitative sensitivity determination to nitroglycerine-based dynamite, pistol and rifle powders, and 2,4-DNT are also reported. Maintenance and procurement guidelines are discussed.

1272 (Y/DA—7702) **X-ray transmission/scattering technique for thickness independent density.** Giacomelli, E.J. (Oak Ridge Y-12 Plant, TN (USA)). 1978. Contract W-7405-ENG-26. 5p. (CONF-781008—1). Dep. NTIS, MF A01.

From ASNT fall conference; Denver, CO, USA (2 Oct 1978). Portions of document are illegible.

This technique was developed to solve the problem of nondestructively measuring density uniformity in a variety of low-Z compressible materials. No existing technique could adequately make this measurement. The measurement concept is based on simultaneously monitoring transmitted and scattered X radiation. Samples of pressed carbon materials were used to evaluate this concept and the viability of using this technique to measure density uniformity has been demonstrated. This technique offers greater precision and is more generally applicable than existing techniques that monitor scattering alone. The measurement concept and its evaluation are described.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

REFER ALSO TO CITATION(S) 1262

1273 (SAND—78-0575C) **Post-gate plasma and sputter process effects on the radiation hardness of metal gate CMOS integrated circuits.** Anderson, R.E. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 8p. (CONF-780707—1). Dep. NTIS, PC A02/MF A01.

From IEEE radiation effects conference; Albuquerque, NM, USA (18 Jul 1978).

With the decreasing dimensions of todays IC's, more attention is being directed towards plasma processing for process simplification and improved control of dimensional tolerances. The desire for high reliability automated assembly techniques has led to the development of the gold bump technology for tape automated bonding. Furthermore, the development of the beam-lead technology continues. All these developments lead to increased use of plasma and sputter processes; therefore, the impact of these processes on radiation hardness must be evaluated. The devices employed in this investigation are CMOS 4007 inverters. They were processed according to the optimized baseline process sequence through Al sinter except that no gate oxide anneal was used. The gate oxide thickness was 700 A. Substrate and p-well resistivities were chosen to give preirradiation p-channel and n-channel thresholds of -2.0 and +3.0 volts respectively. The γ-induced threshold voltage shifts are plotted as a function of the irradiation dose. (WHK)

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 44, 55, 56, 1228, 1244, 1315, 1443, 1446

1274 (CONF-780734—4) **X-ray microanalysis using an HVEM.** Zaluzec, N.J.; Kenik, E.A.; Bentley, J. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From Workshop on analytical electron microscopy; Ithaca, NY, USA (24 Jul 1978).

The interfacing of an energy dispersive x-ray spectrometer (EDS) to an HVEM has been suggested during the last few years as a means by which the mass sensitivity of x-ray analysis in a TEM can be increased. The prediction of higher sensitivity is related to the anisotropic distribution of continuum radiation generated by high energy electron excitation of a thin sample. Depending on the geometry, this can result in an increase in the measured peak-to-background (P/B) ratio of a characteristic line relative to excitation using lower energy electrons. In addition, the unique combination of a large pole piece gap and a wide variety of in-situ experimental stages makes an HVEM an ideal candidate for real-time microanalytical measurements during controlled dynamic events such as precipitation and fracture. A single-crystal specimen of β-NiAl of the 50-50 atomic percent composition was used to evaluate the performance of HVEM-based x-ray microanalysis. The instrument used for the experimental work was a Hitachi HU-1000 high-voltage transmission electron microscope operating at an accelerating voltage of 1 MV. X-ray measurements were made using a KEVEX Si(Li) solid-state x-ray detector with an active area of 10 mm^2 together with a model 5100 multichannel analyzer. (WHK)

1275 (EGG—1183-5089) **Astronomical applications of a computerized video analysis system.** Jekowski, J. (EG and G, Inc., Los Alamos, NM (USA)). 1977. Contract EY-76-C-08-1183. 6p. (CONF-770161—1). Dep. NTIS, PC A02/MF A01.

From 149. meeting of the American Astronomical Society; Hilo, HI, USA (16 Jan 1977).

A computerized video analysis system, suitable for editing, digitizing and processing recorded analog images from astronomical closed circuit television systems has been developed and is in use. The system, built under the auspices of the U.S. ERDA, processes images obtained from special I.R. and visible S.I.T. and I.S.I.T. camera systems. Continuing development of Fortran library routines as subsets of large 7600 and 6600 image processing codes provide utilization of both analog and digital techniques to remove gain, bandwidth and geometric distortion from the data. Recent interconnection of this video system to a P.D.S. micro densitometer and a high speed digital disc allows utilization of both film and electronic recording mediums, providing a technique for comparing data between them. The system employs 525 line interlaced television as a display medium, sacrificing the additional complexity in data reduction for simplified standard instrumentation. A discussion of analog versus digital techniques for recording data, based on three years of operating experience, is included to encourage the application of new technology involving high speed arithmetic units and micro processors as a basis upon which new and more powerful systems may be developed.

1276 (EGG—1183-5090) **Computer controlled video analysis system.** Jekowski, J.P.; Teel, L.E. (EG and G, Inc., Los Alamos, NM (USA)). 1977. Contract EY-76-C-08-1183. 11p. (CONF-770161—2). Dep. NTIS, PC A02/MF A01.

From 149. meeting of the American Astronomical Society; Hilo, HI, USA (16 Jan 1977).

Portions of document are illegible.

The increasing use of closed circuit television for obtaining two-dimensional scientific data has created the problem of processing large amounts of data. A system built at EG and G, Los Alamos Operations, under the auspices of the U.S. ERDA, to handle large quantities of video data by utilizing digital processing and analysis is described. The system ties together the long-standing technology of precision film microdensitometry and the more recent developments of high speed electronic imaging systems. Techniques of computerized video editing, characterization of analog processing devices, analog and digital processing, and applications to the calibration of low light level television systems, infra red scanners and solid state arrays are discussed. The concept of combining three technologies, analog image signal generation, computer processing, and film microdensitometry, is introduced as a basis upon which system performance may be evaluated.

1277 (LA-UR—78-2015) **Tomographical properties of uniformly redundant arrays.** Cannon, T.M.; Fenimore, E.E. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 5p. (CONF-780829—1). Dep. NTIS, MF A01.

From 22. symposium and instrument display; San Diego, CA, USA (28 Aug 1978).

Portions of document are illegible.

Recent work in coded aperture imaging has shown that the uniformly redundant array (URA) can image distant planar radioactive sources with no artifacts. The performance of two URA apertures when used in a close-up tomographic imaging system is investigated. It is shown that a URA based on m sequences is superior to one based on quadratic residues. The m sequence array not only produces less obnoxious artifacts in tomographic imaging, but is also more resilient to some described detrimental effects of close-up imaging. It is shown that in spite of these close-up effects, tomographic depth resolution increases as the source is moved closer to the detector.

1278 (SAND—78-0101) **Operation and maintenance instructions: Tower Alarm Signaling System.** Kraft, C. (Sandia Labs., Albuquerque, NM (USA)). May 1978. Contract EY-76-C-04-0789. 125p. Dep. NTIS, PC A06/MF A01.

The Alarm Signaling System is a set of seven unique circuit cards with a chassis unit which provides power supplies and card mounting facilities. The system is designed to provide a multi-node communications network. At each node a chassis along with selected circuit cards can be configured to perform various functions, from simple data relaying to complex data modification. The one circuit card required at every node is the Special Purpose Logic Component (SPLC) card. This card is a microprocessor which is programmed to perform the data manipulations of the node. The theory of operation and microprocessor program are described in detail.

1279 (SAND—78-0644C) **Intrusion detection sensors.** Williams, J.D. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 20p. (CONF-780917—2). Dep. NTIS, PC A02/MF A01.

From WESCON meeting; Los Angeles, CA, USA (12 Sep 1978).

Intrusion detection sensors are an integral part of most physical security systems. Under the sponsorship of the U.S. Department of Energy, Office of Safeguards and Security, Sandia Laboratories has conducted a survey of available intrusion detection sensors and has tested a number of different sensors. An overview of these sensors is provided. This overview includes (1) the operating principles of each type of sensor, (2) unique sensor characteristics, (3) desired sensor improvements which must be considered in planning an intrusion detection system, and (4) the site characteristics which affect the performance of both exterior and interior sensors. Techniques which have been developed to evaluate various intrusion detection sensors are also discussed.

1280 (SAND—78-0675) **Signal-processing analysis of the MC2823 radar fuze: an addendum re weighting of point targets by position in range cell with an altimeter application.** Williams, C.S. (Sandia Labs., Albuquerque, NM (USA)). Apr 1978. Contract EY-76-C-04-0789. 41p. Dep. NTIS, PC A03/MF A01.

A thorough analysis of the signal processing of the MC2823 radar fuze was presented in 1976 by Thompson based on certain

assumptions concerning circuit components. Subsequent experience has shown that the 0/1 quantizer, the latch, and the effective RF-gate-pulse and transmitter-pulse widths do not exactly meet those assumptions with a resultant change of the effectiveness (or weighting) of a point target at a given range in producing a fire output. A new weighting function, based on laboratory measurements, is derived for use in future analysis. It is also demonstrated herein that this change of the weighting function has negligible effect on the performance analysis provided an equating of the calculated to the measured loop sensitivity is done in order to determine the effective receiver noise. Since this equating has always been done in calculating operational performance of the MC2823 radar fuze, earlier analytical results using Thompson's weighting function can be accepted with confidence. In order for the fuze to operate as a fixed-height indicator on an ascending vehicle, certain additional processing will be required to prevent an early indication of the desired height with a resultant change in sensitivity. Weighting functions for this application are calculated and presented; they indicate that such a change would have little effect on sensitivity.

1281 (Y—2127) **Thermal-emission mass spectrometer for rapid and accurate determination of uranium isotopes.** McBryde, W.T.; Rogers, E.R.; Ferguson, J.R. (Oak Ridge Y-12 Plant, TN (USA)). 31 Aug 1978. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

A 60-degree (π/3-radian) magnetic-sector, 6-inch (152.4-mm) mass spectrometer has been designed and built for uranium isotopic analyses. The instrument uses a Nier-type geometry and has several improvements, both optically and electrically, which make it rapid and precise. Instrument control is good and the analytical results for uranium isotopes are excellent.

1282 (Y/DA—7579) **Surface finish from reflected laser light.** Corey, H.S. (Oak Ridge Y-12 Plant, TN (USA)). 28 Aug 1978. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

The characteristics of reflectance patterns generated when a laser beam strikes a machined surface contain adequate information to determine the degree of surface finish. An extensive development endeavor has established equipment and procedures required to properly extract data from reflectance patterns to obtain a repeatable correlation between the gleaned information and surface finish. Two types of reflective patterns have been utilized: diffracted reflection from single-point-turned periodic surfaces, and diffuse reflection from radom-ground or honed surfaces. Surface finishes ranging from 0.025 to 2 micrometers (1 to 80 microinches), AA, have been measured by using visible laser radiation on the finer surfaces and infrared lasers on rougher materials. Using this method to measure a surface finish provides a noncontact procedure and does not require critical alignment, as is often the case when using a stylus instrument on curved surfaces. Data have been obtained by making full-pattern scans, then integrating the area under the curves, and by measuring the intensity ratio at two predetermined points. Calibration curves have been developed that produce straight lines on log-log graph paper. Also, production inspection equipment has been fabricated to measure the surface finish of parts by the ratio method.

1283 **Diode matrix replacement by programmable read only memories for image analyzer control.** Sand, R.J. (Savannah River Lab., Aiken, SC). *Microscope (Brighton);* **25**: 47-53(1977).

Programming versatility and reliability of automated image analyses were substantially improved by replacing the diode matrix with programmable read-only memories (PROM's) in an Imanco Quantimet (registered trademark) 720 system. The PROM interface, with its 256 random-access instructions, allows alteration of an analysis in progress; the manually inserted diode matrix performs only thirty-two fixed sequence operations.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 131, 504

1284 (UCRL—81294) **Subsurface probing.** Lytle, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Jun 1978. Contract W-7405-ENG-48. 15p. (CONF-780671—1). Dep. NTIS, PC A02/MFA01.

From NSF site characterization workshop; Evanston, IL, USA (12 Jun 1978).

Imaging techniques that can be used to translate seismic and electromagnetic wave signals into visual representation are briefly discussed. The application of these techniques is illustrated on the example of determining the subsurface structure of a proposed power plant. Imaging makes the wave signals intelligible to the non-geologists. R and D work needed in this area are tabulated. (JSR)

1285 **Status and future use of computers for processing and interpreting well logging data.** Aksel'rod, S.M.; Zundelevich, S.M. *Geol. Nefti Gaza;* No. 7, 28-33(Jul 1977). (In Russian).

An examination is made of the technology and methodology of the automatic interpretation of well logging data. An analysis is made of factors which determine the geological efficiency and intensity of introducing autonomous programs and operational systems for the interpretation of well logging results. An identification is made of technical, algorithmic and organizational problems whose solution is essential for the future development of the automatic interpretation of geophysical studies of wells. 2 references.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 1237, 1300

1286 (LA—7245) **Burning and detonation.** Forest, C.A. (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 43p. Dep. NTIS, PC A03/MF A01.

Portions of document are illegible.

The effect of a confined porous bed of burning explosive abutting solid explosive is studied by computer simulation. Burning only is allowed in the porous bed; shock-induced decomposition is modeled by FOREST FIRE in the solid material. The occurrence of detonation in the solid explosive depends on the surface-to-volume ratio, the confinement of the porous bed, and the geometry of the system. The density effect on the initial-shock-pressure, distance-to-detonation (wedge test) measure of shock sensitivity is calculated. The calculation uses the invariance with density of the shock particle velocity as a function of time to detonation.

1287 (LA—7258-MS) **Ignition and initiation of potassium picrate and potassium picrate/explosives mixtures: nonprimary, hot-wire detonators.** Dinegar, R.H. (Los Alamos Scientific Lab., NM (USA)). Aug 1978. Contract W-7405-ENG-36. 11p. Dep. NTIS, PC A02/MF A01.

Potassium picrate (KP) and KP blended with the explosives PETN or HMX can be ignited by a hot wire. Maximum gas pressure generation occurs in several milliseconds and is about 0.3 GPa in a volume of 0.3 cm^3. The shock from detonating PETN initiates small, brass-confined pressings of KP to steady detonation velocities of 3.5 to 5.5 km/s in the density range 1.0 to 1.6 Mg/m^3. KP mixes can be employed as deflagrating donor mixtures in two types of electric detonators. In one the high-pressure deflagration drives a stress wave into an explosive in which the deflagration is transformed into a detonation. In the other the high pressure accelerates a flying plate, which initiates detonation in an acceptor explosive upon impact.

1288 (MHSMP—78-29) **Magnetic probe measurements of PBX 9404 particle velocity. Process development endeavor No. 231.** Campos, C.A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Jul 1978. Contract EY-76-C-04-0487. 11p. Dep. NTIS, PC A02/MF A01.

The axially-symmetric magnetic probe was implemented for direct measurement of particle velocity. The technique was applied to 1.84 Mg/m^3 density PBX 9404. Experimental particle velocities compared very closely with those calculated by the WONDY computer model. It was shown that this explosive very closely resembles the C-J Model Taylor wave, which indicates that it is a very fast acting explosive. Calculated pressures, using the simple jump conditions, from measured particle velocity averaged 354 Kbar.

1289 (MLM—2552(OP)) **Determination of the thermal diffusivity of pyrotechnic materials.** Etter, D.E.; Kaser, D.R.; Wittenberg, L.J. (Mound Facility, Miamisburg, OH (USA)). 1978. Contract EY-76-C-04-0053. 13p. (CONF-780706—14). Dep. NTIS, PC A02/MF A01.

From 6. pyrotechnics seminar; Estes Park, CO, USA (17 Jul 1978).

Thermal diffusivity studies have been initiated to better characterize developmental pyrotechnic materials. Thermal diffusivity, along with density and specific heat, can be used to calculate another important thermophysical property, namely, thermal conductivity. A literature search revealed the relatively simple method commonly known as the flash-diffusivity method. This method, with appropriate modification to accent pyrotechnic materials at elevated temperatures, was selected for these studies.

1290 (MLM—2553(OP)) **Effect of powder compaction variables on the performance of a pyrotechnic igniter.** Munger, A.C.; Seubert, N.J.; Brinkman, J.R. (Mound Facility, Miamisburg, OH (USA)).

1978. Contract EY-76-C-04-0053. 14p. (CONF-780706—17). Dep. NTIS, PC A02/MF A01.

From 6. pyrotechnics seminar; Estes Park, CO, USA (17 Jul 1978).

The compaction of the pyrotechnic powder against a bridgewire in an igniter is very critical to performance. The density of the compact at the bridgewire interface can be effected by the powder characteristics, environment, surface finish and configuration of the compact holder and the loading process. Some of these parameters have been evaluated and the effect determined on the bridgewire-powder interface as well as the initiation performance.

1291 (SAND—78-0035C) **Constitutive equation for the shock response of porous hexanitrostilbene (HNS) explosive.** Hayes, D.B.; Mitchell, D.E. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 18p. (CONF-780813—2). Dep. NTIS, MF A01.

From Symposium on high pressures; Paris, France (22 Aug 1978).

Portions of document are illegible.

A model for treating shock compaction and subsequent chemical decomposition of porous HNS high explosive at initial density 1.6 Mg/m^3 has been tested against results from plane shock initiation experiments. Basically, the model treats the initially porous HNS as a single "pseudothermodynamic" phase, and the compaction process as a phase change. The kinetics that govern subsequent chemical decomposition are determined from gas-gun experiments. Computational experiments were performed using the model to determine the thin pulse threshold pressure sufficient to produce a detonation in the HNS specimen. Threshold pressure was found to depend on the input pulse duration approximately as P/sup 2.65/t = 7.5 GPa/sup 2.65/-μs. This is in agreement with the one available experimental threshold datum P = 6.9 GPa, t = 0.039 μs.

1292 (SAND—78-0271) **Project Misty Castle: distant airblast effects predictions.** Reed, J.W. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 27p. Dep. NTIS, PC A03/MF A01.

An assessment has been made of expected damages from 100 and 600 ton yield chemical explosions at Fort Hood, Texas, under various weather conditions which can distort the airblast propagation. A windowpane survey was made for use with airblast overpressure and damage probability functions to obtain damage predictions. Criteria were established for weather (sound velocities versus height) structures to limit propagation and damage to an acceptable level, and a one-year climatology of suitable firing days was generated. Results show that a 600 ton ANFO explosion could be fired at Fort Hood without causing excessive damage or insult to the surrounding region.

1293 (SAND—78-0466) **Thermal decomposition of the new explosive 2-(5-cyanotetrazolato)-pentaammine cobalt (III) perchlorate.** Searcy, J.Q.; Shanahan, K.L. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 54p. Dep. NTIS, PC A04/MF A01.

A study was made of the thermal decomposition of the new explosive 2-(5-cyanotetrazolato)-pentaamminecobalt (III) perchlorate, or CP, which is being developed for use in detonating components. Loose powder samples from a single lot were heated for various periods of time and analyzed to determine rates of decomposition. Then several techniques were used, including thermal analysis, UV-visible spectroscopy, laboratory chemical analysis, gas chromatography, and mass spectroscopy, to analyze both the gaseous and solid products of decomposition. It was found that the decomposition of CP is a heterogeneous solid-to-gas type reaction which proceeds in three stages with multiple parallel and consecutive reactions. Stage I is an endothermic stage which includes dissociation of ammonia ligands from the cobalt atom, rearrangement of the 5-cyanotetrazolato ligand to produce a nitrogen molecule and an unidentified solid species, and the oxidation-reduction reaction of cobalt (III) with ammonia to produce cobalt (II), nitrogen, and ammonium ion. Stage II, with a higher activation energy, is the oxidation of the ligands around the cobalt atom by the perchlorate ion. Stage III is the oxidation of the residual solid products from Stage I by the perchlorate ion.

1294 (SAND—78-0561) **Qualitative comparison of TATB and PBX 9404 behavior when preheated and ignited under confinement.** Lee, D.O.; Donaldson, A.B. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 16p. Dep. NTIS, PC A02/MF A01.

The results of experiments are presented in which TATB (X-0219) and PBX 9404 specimens were heated and then ignited by a resistance heating element. The insensitive TATB did not detonate and ceased to burn when the heating element was turned off whereas the PBX 9404 appeared to undergo a high order detonation.

1295 (UCID—80470) **Temperature measurement of shock heated solid explosives by time resolved infrared radiometry.** Von Holle, W.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Apr 1978. Contract W-7405-ENG-48. 15p. (CONF-780813—4). Dep. NTIS, PC A02/MF A01.

From Symposium on high pressures; Paris, France (22 Aug 1978).

Experiments utilizing infrared radiometry have yielded measurements of the time resolved temperature of shocked explosive PBX-9404. The results on bare charges indicate the presence of hot spots whose temperature varies strongly with pressure. Interpretation of the results on bare charges is consistent with current theories of heterogeneous initiation. Also, several experiments with transparent, impedance matched overlays were successful in measuring the temperature of the explosive as the pressure at the interface evolved.

1296 (UCRL—80440) **Manganin stress gages in reacting high explosive environment (5. Experimental methods and techniques).** Weingart, R.; Barlett, R.; Cochran, S.; Erickson, L.; Chan, J.; Janzen, J.; Lee, R.; Logan, D.; Rosenberg, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Apr 1978. Contract W-7405-ENG-48. 13p. (CONF-780813—5). Dep. NTIS, PC A02/MF A01.

From Symposium on high pressures; Paris, France (22 Aug 1978).

Manganin stress gages have been fabricated and used successfully to study initiation and detonation of high explosives. These four-terminal, low-impedance gages have been specially designed and encapsulated to minimize the effects of various gage failure mechanisms. Several candidate dielectric encapsulation materials have been tested in the reactive environment, and of these polytetrafluoroethylene has been chosen. Gage stations are formed by thermally bonding the manganin foil between layers of this dielectric. Gages manufactured in this way have been used to provide stress profiles throughout the region of build-up to detonation in PBX-9404 and TATB.

1297 (UCRL—80457) **Detonation chemistry: diffusion control in non-ideal explosives.** McGuire, R.R.; Ornellas, D.L.; Akst, I. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1978. Contract W-7405-ENG-48. 9p. (CONF-780813—6). Dep. NTIS, PC A02/MF A01.

From Symposium on high pressures; Paris, France (22 Aug 1978).

The performance of an explosive is a function of both the peak energy released near the detonation front, and the remainder of the energy that is released during the Taylor wave. The relative partitioning of energy between the front and the expansion, and the rate of energy release in the latter, may be controlled by either chemical kinetic or diffusion processes. Detonation calorimetry has been the principal experimental technique used to investigate these processes. Both the total energy release, and the quantitative analysis of the detonation products at a point or region on the expansion isentrope have been determined for formulations of ammonium nitrate (AN) and TNT in which both the composition and particle size of the AN have been varied. Isotopic labeling of selected explosives has also been used to give further insight into the reactions taking place in or near the reaction zone. Similar experiments have been performed in an ideal, homogeneous explosive.

1298 (UCRL—80486) **Reactions in PBX-9404 from low amplitude shock waves.** Green, L.; Nidick, E.; Lee, E.; Tarver, C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Apr 1978. 17p. (CONF-780813—3). Dep. NTIS, PC A02/MF A01.

From Symposium on high pressures; Paris, France (22 Aug 1978).

The reaction buildup in PBX-9404 from low amplitude (0.4 to 1.4 GPa) shock waves has been studied by impacting thick copper flyers into 146 mm dia specimens containing imbedded manganin pressure gauges. Significant pressure buildup and precursor waves were observed in all experiments. Detonation within 100 mm of run was observed for shock pressures above 1.3 GPa. Hydrodynamic calculations using an extended ignition and growth initiation model were compared to the experimental results. The inclusion of a minimum compression criteria improved the calculations but further refinement of the model will be required to describe low pressure initiation.

NUCLEAR

CIVIL USES

1299 (NVO—195) **Project Gasbuggy well plugging and site restoration plan.** (Department of Energy, Las Vegas, NV (USA). Nevada Operations Office). Jul 1978. 70p. (PNE-G—88). Dep. NTIS, PC A04/MF A01.

The operational plan for conducting the final restoration work at the site of the first U.S. underground nuclear experiment for the stimulation of low-productivity natural gas reservoirs is given. The plan includes well plugging procedures, surface facilities decontamination and removal procedures, radiological guidelines, and environmental considerations.

1300 (RDA-TR—2604-001) **Estimates of crater dimensions for near-surface explosions of nuclear and high-explosive sources.** Cooper, H.F. Jr. (R and D Associates, Marina del Rey, CA (USA)). Sep 1976. Contract W-7405-ENG-48. 54p. Dep. NTIS, PC A04/MF A01.

Crater data from numerous high-explosive (HE) experiments and from fewer nuclear explosive (NE) tests are used to develop an empirically based procedure for predicting crater dimensions from nuclear explosions in various geologic media. The HE crater data are used to rank the cratering efficiency of various geologies. NE crater data from dry soil at the Nevada Test Site and from saturated coral at Eniwetok and Bikini atolls are used to relate NE and HE cratering efficiency. Crater shapes from explosive and impact craters are examined to provide a basis for estimating crater radius and depth in a given geology once the crater volume is known. Best estimates of the crater volume and dimensions are presented along with an estimated range of uncertainty.

1301 (UCRL—52445) **MARVEL revisited: experiment design and data analysis.** Thomsen, J.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Feb 1978. Contract W-7405-ENG-48. 57p. Dep. NTIS, MF A01.

Portions of document are illegible.

As part of the research performed for the Defense Nuclear Agency program defining the in-trench environment for the MX missile system, the nuclear data base was reviewed to determine if any of it was applicable to the problem of air-shock attenuations in long, shallowly-buried tubes. Because of its unique shock-tube geometry, the LLL MARVEL event, fired in 1967, was judged one of the few relevant nuclear events. The MARVEL event is described, including emplacement geometry and emplacement of instrumentation to measure shock time-of-arrival (TOA) in the shock tube. TOA data from the event, including uncertainties, are discussed and analyzed. Finally, using shock-tube theory, the flow parameters D (shock-tube velocity) and P (peak pressure in the air behind the shock front) are derived from a fit to the MARVEL TOA data. The data derived from those parameters are consistent.

1302 (UCRL-Trans—11354) **Experimental nuclear row-charge cratering explosion.** 31 Mar 1978. Translation of scenario text of Russian film by A.S. Kusubov. 9p. Dep. NTIS, PC A02/MF A01.

The Russian film, "An Experimental Nuclear Row-Charge Cratering Explosion," was released by the Soviet Union most likely to promote the Soviet Peaceful Nuclear Explosion (PNE) program outside the USSR. The text contains technical expressions that are useful to serious students of scientific Russian, especially those associated with the U.S. PNE program. The edition of the scenario text is intended to be used for instruction in scientific Russian; the sound track might be studied during language laboratory study, and later the film could be run silently in class, with students supplying the description of events in Russian.

WEAPONRY

1303 (UCRL—52466) **LLL hydrodiagnostics upgrade program.** Carpluk, G.T.; Innes, T.G.; Trost, S.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Jun 1978. Contract W-7405-ENG-48. 31p. Dep. NTIS, PC A03/MF A01.

The continued success of the nuclear weapon design and test programs is a direct result of the effective hydrodynamic programs developed at Livermore. Hydrodynamic studies provide the weapon designer with experimental verification and analysis of weapon designs through the use of explosively driven, nonfissile materials. Hydrodiagnostic techniques include (1) flash radiography; (2) high-speed photography; (3) electrical-pin diagnostics; and (4) interferometry. The focus of all hydrodynamic testing at LLL is the Site 300 Explosive Test Area located 18 miles east of Livermore. This remote, 10-mi^2 facility consists of: (1) areas for machining and assembling explosives; (2) environmental test facilities; (3) administrative and support facilities; and (4) five underground, reinforced-concrete bunkers equipped with high-speed cameras, electrical data-acquisition systems, and electron accelerators for flash radiography. The report summarizes the improvements made in radiography, optics, electronics, and interferometry, and indicates the projects that remain to be completed.

EXPLOSION DETECTION

1304 (AD-A—051605) **Study of selected Kamchatka earthquakes in a seismic discrimination context. Technical report.** von Seggern, D.H.; Sobel, P.A. (Teledyne Geotech, Alexandria, VA (USA). Seismic Data Lab.). 16 Aug 1977. Contract F08606-77-C-0014. 115p. (SDAC-TR—76-10). NTIS PC A06/MF A01.

Seismic discrimination in the Kamchatka source region is studied using data from earthquakes, inferences from measurements of teleseismic explosions, and results from the Amchitka tests. On the basis of several parameters taken together, such as M sub s - m sub b, spectral ratio, corner frequency, complexity, long-period body-wave excitation, and shear-wave excitation, discrimination of events of this type in the Kamchatka region poses no special problems so long as discrimination against shot arrays is not at issue. If shot arrays are considered, then the problem is more difficult, but still tractable.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

REFER ALSO TO CITATION(S) 820

BASIC STUDIES

REFER ALSO TO CITATION(S) 848, 1322

1305 **Two-dimensional numerical simulation of the effects of air pollution upon the urban—rural complex.** Welch, R.M.; Paegle, J.; Zdunkowski, W.G. (Univ. of Utah, Salt Lake City). *Tellus;* **30**: No. 2, 136-150(Apr 1978).

A two-dimensional radiative-dynamic interaction model is developed to study the impact of air pollution on urban areas and on the regions directly downwind of the city. By isolating component effects, such as variable soil parameters and roughness heights, it becomes possible to comprehend the behavior of the complete model. The model includes low and elevated pollution as well as artificial urban heat sources. Geostrophic winds of 2 and 5 m/s are used to model the wind field, vertical motion is included. Stability effects on vertical mixing are accounted for in terms of the similarity theory. The radiative treatment is based on the exact formulation of the radiative transfer equation which accounts for multiple scattering of aerosol particles in the solar spectrum as well as in the water vapor window. In addition to the radiative effects of water vapor and carbon dioxide, the presence of NO_2 is accounted for. It is found that an artificial heat source causes surface heating of 4°C, while urban soils lead to lower surface temperatures up to 4°C during the day and warmer temperatures up to 3°C during the night. The effect of increased roughness is an increased temperature up to 4°C at shelter height during the day and a decreased temperature of 2.5°C during the night. Low-level pollution sources lead to 2°C surface temperature decrease during the day, while upper level sources may lead to decreases of 7°C under stagnant conditions in urban areas.

1306 **Baccalaureate programs in environmental engineering.** Patterson, J.W. (Illinois Inst. of Tech., Chicago); Male, J.W. *Eng. Educ. (Wash., D.C.);* 319-322(Jan 1978).

As shown by the enrollment figures, undergraduate environmental engineering education has grown very quickly in the past six years. Is this growth indicative of the need and usefulness of such a discipline. Most of the programs reviewed were created immediately following the environmental awareness of the late sixties. Since that time graduate environmental engineering enrollments have declined from a variety of causes. We cannot yet tell if undergraduate environmental engineering enrollments will stabilize at the present level, continue to increase, or decline. Enrollment will depend, in large part, on the degree of public awareness of the discipline and the demand for graduates in the field.

1307 **Testing toxic substances for protection of the environment.** Draggan, S.; Giddings, J.M. (Oak Ridge National Lab., TN). *Sci. Total Environ.;* **9**: No. 1, 63-74(Jan 1978).

The Toxic Substances Control Act requires pre-production testing of chemicals for potential hazards to human and environmental health. Effective control of chemicals requires evaluations of chemical hazard that go beyond determinations of toxicity to humans to include the effects, transport, and fate of chemicals in the environment. Formulation of meaningful hazard evaluations depends on integrating information from tests of chemical effects, transport, and fate or by developing testing tools that integrate these factors during experimentation. Chemical effects may be acute or chronic and they may be observed in individual organisms, populations of

organisms, or in total ecosystems. Chemical transport through the environment depends on physico-chemical characteristics of the chemical and the medium (soil, water, or air) as well as environmental factors and biotic processes. The ultimate fate of chemicals (persistence, transformation, or degradation) is determined by numerous physical and biological processes occurring in the environment, and must be acknowledged to effectively determine the hazard. Many techniques are available for the separate and routine evaluation of the effects, transport and fate of environmental contaminants. However, separate identification of the importance and magnitude of each of these factors limits their utility in assessments of chemical hazard. The microcosm (model ecosystem) method integrates many of these tests in replicable experimental units, and may provide substantial information on chemical hazard in ecosystem context.

RADIOMETRIC TECHNIQUES

1308 Tracer simulation using a global general circulation model: Results from a midlatitude instantaneous source experiment. Mahlman, J.D.; Moxim, W.J. (Geophysical Fluid Dynamics Laboratory, NOAA, Princeton University, Princeton, N. J. 08540). *J. Atmos. Sci.;* **35**: No. 8, 1340-1398(Aug 1978).

An 11-level general circulation model with seasonal variation is used to perform an experiment on the dispersion of passive tracers. Specially constructed time-dependent winds from this model are used as input to a separate tracer model. The methodologies employed to construct the tracer model are described.The experiment presented is the evolution of a hypothetical instantaneous source of tracer on 1 Janaury with maximum initial concentration at 65 mb, 36 °N, 180 °E. The tracer is assumed to have no sources or sinks in the stratosphere, but is subject to removal processes in the lower troposphere.The experimental results reveal a number of similarities to observed tracer behavior, including the average poleward-downward slope of mixing ratio isopleths, strong tracer gradients across the tropopause, intrusion of tracer into the Southern Hemisphere lower stratosphere, and the long-term interhemispheric exchange rate. The model residence times show behavior intermediate to those exhibited for particulate radioactive debris and gaseous $C^{14}O_2$. This suggests that caution should be employed when either radioactive debris or $C^{14}O_2$ data are used to develop empirical models for prediction of gaseous tracers which are efficiently removed in the troposphere.In this experiment, the tracer mixing ratio and potential vorticity evolve to very high correlations. Mechanisms for this correlation are discussed. The zonal mean tracer balances exhibit complex behavior among the various transport terms. At early stages, the tracer evolution is dominated by eddy effects. Later, a very large degree of self-cancellation between mean cell and eddy effects is observed. During seasonal transitions, however, this self-cancellation diminishes markedly, leading to significant changes in the zonal mean tracer distribution. A possible theoretical explanation is presented.

1309 Analytical standard for the uranium milling industry. Sill, C.W. (Energy Research and Development Administration, Idaho Falls, ID). pp 221-224 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

During milling operations for the production of uranium large quantities of solid, liquid, and gaseous byproducts are generated that contain various quantities of uranium and its daughter activities that were present in the original ore. Many of these daughter activities are long-lived, alpha-emitting bone seekers that produce severe biological consequences when taken internally by man. Their accurate and reliable identification and measurement in a wide-range of materials is of greatest importance in assessing their impact on the public health. Although several analytical procedures are available for each of the radionuclides concerned, different laboratories frequently get significantly different results on a given sample, even when the procedure used is virtually the same. A standard reference material of cleaned pitchblende ore containing accurately known concentrations of each of the radionuclides of interest was tested and found accurate for comparison of values for ^{238}U, ^{239}U, ^{231}Pa, all of which were statistically identical to the calculated values at the 95% confidence level.

1310 Simultaneous determination of ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, and ^{210}Pb in uranium ore, dusts and mill tailings. Sill, C.W. (Energy Research and Development Administration, Idaho Falls, ID). pp 225-245 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

A procedure is described for determination of the five most important radionuclides in the ^{238}U series in the same sample to eliminate apparent changes in the isotopic composition caused by sample inhomogeneity, and to maximize sensitivity and precision on air dusts when only small samples are available. The sample is decomposed with hydrofluoric acid and pyrosulfate acid and pyrosulfate fusion to guarantee complete conversion of refractory compounds to the ionic state before chemical separations are attempted. Thorium and radium are separated from the hydrochloric acid solution of the pyrosulfate cake by precipitation on barium sulfate. Thorium is then extracted into bis(2-ethylhexyl)phosphoric acid, electrodeposited and analyzed by alpha spectrometry. Radium is determined by the emanation procedure. Lead and bismuth are extracted into diethyldithiocarbamate from the filtrate from the barium sulfate separation, and ^{210}Pb is determined by beta counting its ^{210}Bi daughter. Uranium is extracted into Aliquat 336, after prior concentration on barium sulfate when the quantity of uranium present is small, electrodeposited and analyzed by alpha spectrometry. Isotopic tracers for thorium and uranium are used and chemical yields for all four elements are higher than 90%.

1311 Direct measurement of radionuclides in uranium mill tailings, ores, and dust. Perkins, R.W.; Thomas, C.W. (Pacific Northwest Div., Richland, WA). pp 255-274 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

The feasibility of measuring some of the more important long-lived radionuclides in the ^{238}U series and also the measurement of ^{235}U was demonstrated. This was accomplishd by the use of a large area intrinsic germanium diode. The accuracies of the measurements are adequate for most purposes and the analytical procedure is far simpler and more rapid than chemical separations techniques. This instrumental analytical procedure should be particularly useful in surveys of uranium tailings areas where hundreds to even thousands of analyses are required. It should also be useful in determining the degree of disequilibrium of uranium ores and in ore dust generated in the milling process.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 5, 117, 122, 123, 318, 1140, 1250, 1342, 1360, 1560

1312 (BNL—24366) **Operating parameters affecting sulfate emissions from an oil-fired power unit.** Dietz, R.N.; Wieser, R.F.; Newman, L. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 45p. (CONF-780481—1). Dep. NTIS, PC A03/MF A01.

From Workshop on measurement technology and characterization of primary sulfur oxides emission from combustion sources; Southern Pines, NC, USA (24 Apr 1978).

The field utilization of the Brookhaven controlled condensation system at several oil-fired power plant units demonstrated the capability of a reasonably simple but quite reliable approach to the sampling of flue gas for the specific constituents, H_2SO_4 and total particulates; the latter were subsequently separated into a water soluble and insoluble fraction. The soluble fraction was shown to be entirely composed of water soluble metal sulfates, principally of Mg, V, and Na. Carbon was the main element in the insoluble fraction which also contained metal oxides primarily of Mg, V, and iron. It was conclusively shown that unless the flue gas sampling method used to study the effect of operating parameters on the emission of total sulfates was specific for H_2SO_4 and metal sulfates, the exact nature of the mechanisms responsible for the variability of sulfate emissions would have been more difficult to ascertain.

1313 (BNL—24367) **Evaluation of the modified EPA Method 6 flue gas sampling procedure.** Dietz, R.N.; Wieser, R.F.; Newman, L. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 34p. (CONF-780481—2). Dep. NTIS, PC A03/MF A01.

From Workshop on measurement technology and characterization of primary sulfur oxides emission from combustion sources; Southern Pines, NC, USA (24 Apr 1978).

The character of primary sulfate emissions (i.e., H_2SO_4 and water soluble metal sulfates) must be determined with flue gas sampling methods that differentiate between the acid form and the less nocuous metal sulfates, both for consideration of potential health effects and for determination of the mechanisms and parameters which affect the magnitude and distribution of those emissions. As presently recommended, the modified version of the EPA Method 6 does not provide for specific determination of particulate metal sulfates and H_2SO_4. This paper describes an improved version of the

isopropyl alcohol (IPA) bubbler technique for collection of sulfuric acid that can reduce the errors associated with neglecting the correction for the presence of an oxidant in the IPA and the inability to entirely strip the dissolved SO_2 prior to determination of H_2SO_4. Laboratory and field experimental results confirmed the existence of both phenomena as well as the apparent existence of a volatile oxidant in the flue gas which converted SO_2 to H_2SO_4 in the IPA.

1314 (CAES—490-77) **Statistical analysis of the operating parameters which affect cupola emissions.** Davis, J.W.; Draper, A.B. (Pennsylvania State Univ., University Park (USA)). Dec 1977. Contract EY-76-S-02-2840. 154p. Dep. NTIS, PC A08/MF A01.

A sampling program was undertaken to determine the operating parameters which affected air pollution emission from gray iron foundry cupolas. The experimental design utilized the analysis of variance routine. Four independent variables were selected for examination on the basis of previous work reported in the literature. These were: (1) blast rate; (2) iron-coke ratio; (3) blast temperature; and (4) cupola size. The last variable was chosen since it most directly affects melt rate. Emissions from cupolas for which concern has been expressed are particle matter and carbon monoxide. The dependent variables were, therefore, particle loading, particle size distribution, and carbon monoxide concentration. Seven production foundries were visited and samples taken under conditions prescribed by the experimental plan. The data obtained from these tests were analyzed using the analysis of variance and other statistical techniques where applicable. The results indicated that blast rate, blast temperature, and cupola size affected particle emissions and the latter two also affected the particle size distribution. The particle size information was also unique in that it showed a consistent particle size distribution at all seven foundaries with a sizable fraction of the particles less than 1.0 micrometers in diameter.

1315 (CONF-780819—20) **Remote sampling system for HEPA (1500 cfm) in-place filters with a fluid (channel) seal system.** Musen, L.G. (Idaho National Engineering Lab., Idaho Falls (USA)). 1978. Contract EY-76-C-07-1570. 15p. Dep. NTIS, MF A01.

From 15. nuclear air cleaning conference; Boston, MA, USA (Aug 1978).

Portions of document are illegible.

The most important consideration in measuring the toxic risk in an air-moving system is to obtain a representative sample of the air and the toxic agents moving in the air stream. This paper describes the use of a commercially available system for sampling the air moving through high efficiency particulate aerosol (HEPA) filter units. These units consisted of a "crab trap," a separatorless filter with a channel (fluid) system seal, and a specially designed air injection and sample probe system. The probe was found efficient for use in a turbulent or laminar flow duct using a monodispersed or polydispersed aerosol from 0.3 to 10 μ in diameter. This type of system provides longer filter life, reduces testing time, reduces possible personnel exposures, and enables accurate sampling in areas where accessibility is poor.

1316 (FAA-AEQ—77-14) **Concorde air quality monitoring and analysis program at Dulles International Airport. Volume I. Final report.** Smith, D.G.; Yamartino, R.J.; Benkley, C.; Isaacs, R.; Lee, J.; Chang, D. (Department of Transportation, Washington, DC (USA)). Dec 1977. Contract W-31-109-ENG-48. 176p. Dep. NTIS, PC A09/MF A01.

On February 4, 1976, the Secretary of Transportation ordered the FAA to monitor Concorde emissions at Dulles International Airport during its initial 16 month trial period. To comply with this order, it was necessary to measure the ambient pollution levels (background) in and around Dulles Airport and to trace the dispersion of emissions from a single Concorde aircraft. While the more conventional background measurements could be easily performed, there was no known case where the vertical and horizontal profile of the emission plume from a single aircraft had been identified. Special instruments were required to measure the discrete, non-steady nature of the dispersion of the aircraft plume. The final measurement system, which consisted of continuously recording electro-chemical sensors coupled with high-speed chart recorders, successfully detected CO emissions from a single aircraft. Concorde CO emissions from taxiing aircraft dilute to background levels within 2,000 ft and do not reach the terminal in measurable amounts. Emissions from the airport property could not be detected at Sterling Park, or several more distant communities, even when the winds were blowing toward them from the airport. Actual Concorde operations were less polluting than had been indicated in the Final Environmental Impact Statement (FEIS).

1317 (FOA-C—30124-E1) **"Stenungsund-77": smoke plume measurements with a pulsed dye laser.** Gustafsson, G.; Hartmann, B.; Spangstedt, G.; Steinvall, O. (Foersvarets Forskningsanstalt, Stockholm (Sweden)). Dec 1977. 35p. Dep. NTIS (US Sales Only), PC A03/MF A01.

This report describes some of the results obtained in a field experiment at Stenungsund in May 1977, under the support and coordination of the Swedish Space Corporation. We made lidar measurements with a pulsed tunable dye laser working at wavelengths in the uv and visible part of the spectrum. The study concerned SO_2-absorption, NO_2-absorption, and particle scattering in the smoke plume of an oil fuel electric power plant. The SO_2-burden in the plume, near the smoke stack exit, as estimated from our lidar measurements, is compatible with in situ measurements and calculated values. The NO_2-concentration proved to be lower than the sensitivity limit of our lidar system. The particle scattering experiments led to qualitative results, and only permitted order of magnitude estimates of particle concentrations. They show, however, that a low power, eye safe uv lidar was capable of tracking plumes undiscernible to the eye, out to a distance of 2 to 3 km.

1318 (LA—7295-PR) **Development of air-monitoring techniques using solid sorbents, LASL Project R-059, NIOSH-IA-77-12, October 1, 1976—December 31, 1977.** Wood, G.O.; Nickols, J.W. (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 68p. Dep. NTIS, PC A04/MF A01.

A project for developing personal sampling and analytical methods for vapors of amine and hydrazine compounds in air is completed with this report. Silica gels and acid-coated silica gels were evaluated for vapor collection, stability, and recovery of amines for analysis. The coumpounds 2-aminoethanol, ethylenediamine, and diisopropylamine were used for most of these experiments as representatives of aminoalcohols, aliphatic polyamines, and aliphatic amines, respectively. A silica gel tube was designed for sampling and its adsorption capacities were defined for several amines. Stabilization of samples for storage and transportation was accomplished by the addition of concentrated hydrochloric acid. An analytical procedure was developed that involves sample elution with methanol-water solvent, reaction of primary amines with benzaldehyde, and analysis by gas chromatography. Each phase of this procedure was tested to select the optimum conditions and define the limitations. The final sampling and analysis procedure developed for 2-aminoethanol, 2-diethylaminoethanol, and 2-dibutylaminoethanol is summarized and detailed. The procedure for ethylenediamine and diethylenetriamine and an improved method for methylamine is given. Recommendations for improvements in the analysis of methylhydrazine are also given.

1319 (LA—7321-MS) **Heavy methanes (mass-20 and -21) as atmospheric tracers. A new research initiatives project.** Guthals, P.R.; Fowler, M.M. (comps.). (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-38. 101p. Dep. NTIS, PC A06/MF A01.

Products from the stable isotope production project (ICONS) at the Los Alamos Scientific Laboratory (LASL) have had applications in a number of practical problems. Fully deuterated methanes, using ^{12}C and ^{13}C (mass-20 and -21, respectively), are detectable in the atmosphere at very low concentrations. The detection limits are due to an almost zero background and a distinct mass-spectrometric line. These properties, coupled with long lifetimes in the atmosphere, make the heavy methanes strong candidates for tracers of atmospheric transport and turbulence on regional to global scales. Three field tests have been conducted to assess the feasibility and to demonstrate the desirable properties of heavy methanes as atmospheric tracers. In the first test in May 1974, heavy methane released at the Idaho National Engineering Laboratory (INEL) was sampled and detected in several midwestern cities up to 2500 km downstream. These results agree with trajectories estimated from observed meteorological data. A second experiment, conducted in December 1975 at the Savannah River Plant, compared two heavy methanes with SF_6 and ^{85}Kr over a transport distance of 100 km. Increased detail in meteorological support data and ground-level sampling offered options of data interpretation unavailable in the first test. Qualitative patterns of tracer concentrations show good agreement among the four tracers and are verified by the meteorological inputs. The third experiment, performed in April 1977 at INEL, built on the experience of the previous two. Detailed ground-level sampling arrays at 3, 50, and 90 km from the release point were supplemented by aircraft and a crude sampling line across the Continental Divide at 300-km distance. Two new perfluorocarbon tracers were included for comparison.

1320 (LA—7375-PR) **Development of sampling and analytical methods for carcinogens. Progress report, October 1, 1976—December 31, 1977.** Morales, R.; Stampfer, J.F. Jr.; Hermes, R.E.; Campbell, E.E.; Ettinger, H.J. (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 28p. Dep. NTIS, PC A03/MF A01.

Sampling and analytical procedures to monitor 4-aminobiphenyl, 4-nitrobiphenyl, and 4-dimethylaminoazobenzene in air are described. These compounds were designated as carcinogens by the Occupational Safety and Health Administration in 1974. The sampling tubes developed for the carcinogen consist of a glass fiber filter

followed by beds of adsorbent and are thus able to collect both aerosols and vapors. Gas chromatography with a flame ionization detector was used to quantitate microgram levels of the carcinogens in air. The chromatographic procedures provided good resolution of the carcinogens from possible contaminants. Results of respirator canisters evaluated for protection against the above compounds are also given.

1321 (ORNL/EIS—109) **Changes in the global carbon cycle and the biosphere.** Olson, J.S.; Pfuderer, H.A.; Chan, Y.H. (Oak Ridge National Lab., TN (USA)). Jul 1978. Contract W-7405-ENG-26. 176p. Dep. NTIS, PC A09/MF A01.

Increases in atmospheric CO_2, risks of climatic change, and impacts from such change are reviewed. Needs for closer scrutiny of changes in organic carbon and in the patterns of the biosphere are explained. The organic carbon pool is considered here as a moderate source of CO_2, perhaps 1 to 3 Gtons/yr in recent years. The biosphere could become a net sink for CO_2 if it were managed optimally to minimize the future peak of atmospheric CO_2 and to maximize storage as well as production rates of organic carbon. A preliminary global computer model explores the implications of tropical and subtropical forest clearing as a nonfossil source of CO_2 as well as some limits on the biosphere's role as a potential sink. Because of these limits and the oceanic factors of carbonate buffering, slow physical circulation, and limited net sedimentation of carbon, models confirm that 4- to 7-fold increases of CO_2 could occur if projections of high fossil energy consumption were to materialize. Review of climatic changes does not support beliefs that cooling would become great enough to counteract the mean surface temperature rise of 2 to 9°C in 100 years. Changes in climate pattern, temperature, drought, and waterlevel, and in their varied biological effects, would interact to change success of crops, other ecosystems, and many social institutions.

1322 (UUIM—50) **Sodar measurements of the boundary layer during the field project Stenungsund-77.** Salomonsson, S.; Ivarsson, J. (Uppsala Univ. (Sweden). Meteorologiska Institutionen). 1978. 32p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Results obtained by two vertically pointing monostatic echo sounders, also called sodars, used in the air pollution project "Stenungsund-77" are discussed. Disregarding minor breaks, a continous record for about 10 days was collected. A comparison is made between sodar records obtained at a coastal site and at an inland site. The interpretation of the sodar data is supported by vertical temperature profiles obtained by regular radiosoundings at Goteborg-Torslanda airport 45 km south of the measuring site. Also climatological data of temperature and wind are used in the analysis. Two sets of airborne measurements of plume diffusion and temperature stratification are presented. The influence of the air mass stratification on the boundary layer dynamics is demonstrated, especially in connection with frontal passages. An estimate of the local strength of an upper inversion is made by combining the sodar record with surface temperature data and radiosond data. Vertical velocities are derived from the Doppler shift of the return signal for a brief period of time. Plume characteristics are discussed in relation to measurements of particle content and temperature stratification.

1323 **Ratio of HNO_3 to NO_2 concentrations in daytime stratosphere.** Harries, J.E. (National Physical Lab., Teddington, Eng.). *Nature (London);* **274**: No. 5668, 235(20 Jul 1978).

The letter reports independent determinations of the $[HNO_3]/[NO_2]$ ratio which apparently support the measured values at levels above 25 km, but which are nearer the calculated values below this level. A detailed comparison of the two sets of data is given.

1324 **Subisokinetic sampling errors for aircraft turbine engine smoke probes.** Martone, J.A. (U.S. Air Force Armament Development and Test Center, Tyndall AFB, FL). *J. Air Pollut. Control Assoc.;* **28**: No. 6, 607-609(Jun 1978).

The recent aerosol sampling data reported by Martone et al. has been used to establish the validity of extending Zenker's results to predict subisokinetic sampling errors in compressible flows. The prediction technique was applied to sampling gas turbine engine exhausts using an ARP 1179 smoke probe. The analysis shows that a smoke probe may produce a 15 to 30% subisokinetic sampling error at a take-off engine power setting. These errors do not greatly affect smoke number determinations but should be considered when true smoke density is measured.

1325 **Light scattering by particulate emissions from vehicles on the road.** Pierson, W.R.; McKee, D.E. (Ford Motor Co., Dearborn, MI). *J. Air Pollut. Control Assoc.;* **28**: No. 6, 604-607(Jun 1978).

Improved methods for studying atmospheric light scattering caused by road vehicles are discussed. It was determined that roadway visibility was not substantially affected by vehicular aerosols and that most of the light scattering should be from Diesel vehicle aerosols.

1326 **Computer-oriented emissions inventory procedure for urban and industrial sources.** Runca, E.; Zannetti, P.; Melli, P. (IBM Italia, Venice). *J. Air Pollut. Control Assoc.;* **28**: No. 6, 584-588(Jun 1978).

A knowledge of the rate of emission of atmospheric pollutants is essential for the enforcement of air quality control policies. A computer-oriented emission inventory procedure has been developed and applied to Venice, Italy. By using optically readable forms this procedure avoids many of the errors inherent in the transcription and punching steps typical of approaches applied so far. Moreover, this procedure allows an easy updating of the inventory. Emission patterns of SO_2 in the area of Venice showed that the total urban emissions were about 6% of those emitted by industrial sources.

1327 **Downdraft field chamber for studying the effects of air pollutants on plants.** Runeckles, V.C. (Univ. of British Columbia, Vancouver); Staley, L.M.; Bulley, N.R.; Black, T.A. *Can. J. Bot.;* **56**: No. 7, 768-778(1 Apr 1978).

A new type of field exposure chamber for air pollution studies is described and its performance is evaluated. The chamber is designed to provide a steady downward air flow over a 2.44-m-diameter plot, with air venting laterally at soil level. It consists of a filter box above a 0.92-m-diameter fan in a housing mounted atop a conical welded steel frame. The fan is located 4.9 m above soil level. The frame enlarges from a diameter of 1.22 m at the top to 2.44 m at the base and is enclosed within a 0.5-mm (20-mil) polyvinylchloride cover terminated 20 cm above soil level. Activated charcoal and dust filters above the fan reduce the levels of ambient pollutants, particularly particulates and oxidants. Pollutant gases to be studied are introduced immediately below the fan to ensure mixing. Measurements of air velocity and the concentration of introduced pollutants indicate uniform distribution with considerable turbulence, while net radiation and temperature measurements indicate a small greenhouse effect due to the presence of the superstructure. The performance of the chamber is compared with others in use under field conditions.

1328 **Dew as a sink for sulphur dioxide.** Brimblecombe, P. (Univ. of East Anglia, Norwich, Eng.). *Tellus;* **30**: No. 2, 151-157(Apr 1978).

Calculations suggest that transfer of SO_2 into leaf wetness ("dew") is relatively rapid and it should remain in equilibrium with the atmosphere. The volume of leaf wetness appears to be insufficient to absorb more than 0.3% of the SO_2 emitted in the U.K. each year unless it is neutralized by alkaline materials such as ammonia. Analysis of leaf wetness in winter at a semirural site gave SO_4^{2-} as $1.06 \pm 0.56 \times 10^{-4}$ mol l^{-1} which places the maximum deposition into "dew" over the U.K. at 0.12 Mtonne yr^{-1} (2.3% of emissions).

1329 **Seasonal trends of NH_4^+ and NO_3^- nitrogen isotope composition in rain collected at Juelich, Germany.** Freyer, H.D. (Inst. of Chemistry, Juelich, Ger.). *Tellus;* **30**: No. 1, 83-92(Feb 1978).

Data are presented on nitrogen isotope composition in ammonium and nitrate from rain-water collected over 2 years in an interior area at Julich, Germany. The seasonal trends in these data are discussed relative to natural and anthropogenic emissions of nitrogen compounds which additionally have been measured or estimated in their isotope composition, e.g. ammonia from animal urine, fuel combustion, fertilizer use and organic soil nitrogen, and natural and anthropogenic nitric oxides from automobile exhausts as well. The ^{15}N content of Julich rain ammonium is found to be different from values of Hoering (1957) and Moore (1974) and from other rain samples collected in coastal areas.

1330 **Modelling air pollution in Leeds (U.K.).** Clarke, A.G.; Gascoigne, M.; Henderson-Sellers, A.; Williams, A. (Univ. of Leeds, Eng.). *Int. J. Environ. Stud.;* **12**: No. 2, 121-132(1978).

An investigation of theoretical models of dispersion of pollutants within the urban area of Leeds is described. Attention is centered on the problems of successful prediction (and hence control) of situations leading to low levels of visibility in the city area. The importance of knowledge of local meteorological parameters is underlined especially for the successful prediction of urban visibilities. In particular, the need for an accurate method for describing the changing value of the local mixing height has led to development of a complex numerical model. This model will be useful for environmental planning and particularly for siting of new industrial areas and overspill urban developments.

1331 **Acidic sulfate aerosols: formation from heterogeneous oxidation by O_3 in clouds.** Larson, T.V.; Harrison, H. (Univ. of Washington, Seattle). *Atmos. Environ.;* **11**: No. 12, 1133-1141(1977).

We present a mathematically closed approximation which relates the extent of acid-sulfate aerosol production to the time for SO_2 oxidation by O_3 in cloud droplets. In warm clouds (278 K) of moderate liquid water content (equal to or less than 0.6 g/m^3) exposed to typical background levels of O_3 (equal to or greater than 50 ppbv), this reaction can produce submicron particles in times

equal to or less than 1 day with a resulting NH_4^+/SO_4^{2-} molar ratio equal to or greater than 1.5, an SO_2/SO_4^{2-} molar ratio equal to or greater than 4, and a sulfate mass concentration of about 20 $\mu g\ m^{-3}$. All these values are typical of the atmosphere, which suggests that this reaction is an important SO_2 oxidation pathway.

1332 Size discrimination and chemical composition of ambient airborne sulfate particles by diffusion sampling. Tanner, R.L.; Marlow, W.H. (Brookhaven National Lab., Upton, NY). *Atmos. Environ.;* **11**: No. 12, 1143-1150(1977).

A sampling method is described by which aerosol particles with diameters below the optical scattering region (less than 0.3 μm) are separated into size-related fractions in a battery of diffusion cells of exceptional length. The separated particles are then efficiently collected on chemically inert, acid treated quartz filters and the chemical composition of the collected sulfate-containing particles determined by state-of-art analytical techniques. Concurrently, the particle size distributions (by number) are determined by monitoring the airborne particle content after increasing numbers of diffusion cells with a condensation nuclei counter (CNC). This diffusion sampling method for chemical speciation of sulfate on filter samples and simultaneous particle size determination from CNC data was successfully evaluated during an 8-day period at rural Glasgow, IL, in July, 1975. We conclude from the data that: (a) one episode of high sulfate concentrations also exhibited high acid levels and showed complementary diurnal variation of acid and ammonium levels, whereas sulfate in two other episodes was much less acidic and no diurnal pattern was discernible; (b) aerosol volumes in untreated and diffusion-processed particle samples are correlated with sulfate and with the sum of acid and ammonium concentrations; (c) roughly 50 per cent of sulfate mass in airborne particles was found in the size range less than about 0.3 μm dia. during this sampling period; and (d) sulfate as a fraction of aerosol mass was higher in suboptical aerosol particles than in the total aerosol mass.

1333 London air pollution, 1500—1900. Brimblecombe, P. (East Anglia Univ., Eng.). *Atmos. Environ.;* **11**: No. 12, 1157-1162(1977).

Documentary evidence for the changes in the air pollutant levels and climate of London are compared with the results obtained from a simple single box model for the annual mean SO_2 and particulate levels in the London air. Sulphur dioxide reaches a maximum of nearly 200 $\mu g\ m^{-3}$ in a plateau that stretches from 1690 to 1880. Particulate concentrations show a peak at the end of the 19th century.

1334 Mathematical model for transport, interconversion, removal of gaseous and particulate air pollutants: application to the urban plume. Peterson, T.W.; Seinfeld, J.H. (California Inst. of Tech., Pasadena). *Atmos. Environ.;* **11**: No. 12, 1171-1184(1977).

A steady state, three-dimensional solution of the atmospheric diffusion equation including settling, deposition, and first-order removal is presented. The solution is applied to the prediction of airborne concentrations of gaseous and particulate pollutants in the case in which gases are converted to secondary particulate matter. The conversion of sulfur dioxide, nitrogen oxides, and hydrocarbons to particulate sulfate, nitrate, and organics in the Los Angeles atmosphere and urban plume is analyzed.

1335 Mathematical modelling of the meso-scale transport of gaseous pollutants. Maul, P.R. (Central Electricity Generating Board, Nottingham, Eng.). *Atmos. Environ.;* **11**: No. 12, 1191-1195(1977).

A model for the dispersion of gaseous pollutants based on analytical solutions of the steady-state diffusion equation is described. Important physical processes such as dry deposition are included and the boundary layer structure is simulated. The model is shown to be applicable over a wide range of travel distances, but to be most useful for meso-scae distance (20 to 100 km), where Gaussian plume and box models have many limitations. In this region, computational costs are usually well below those incurred by using numerical solutions of the diffusion equation.

1336 Fast response sensor for ozone eddy-correlation flux measurements. Eastman, J.A.; Stedman, D.H. (Univ. of Michigan, Ann Arbor). *Atmos. Environ.;* **11**: No. 12, 1209-1211(1977).

The measurement of fluxes of gaseous pollutants to the ground may be made using eddy-correlation techniques. The application of a chemiluminescent and other fast response detectors is discussed. As an example, a specific study of ozone fluxes is described.

1337 Deposition of H_2S and dimethyl sulfide on selected soil materials. Judeikis, H.S.; Wren, A.G. (Aerospace Corp., Los Angeles). *Atmos. Environ.;* **11**: No. 12, 1221-1224(1977).

Although much work has been done on the dry deposition of oxidized atmospheric sulfur containing species onto ground level surfaces, little is known of the rates of deposition of reduced sulfur compounds. Here we report on laboratory measurements of deposition velocities of H_2S and dimethylsulfide (DMS) on selected soil samples. Measured deposition velocities lie in the range of 0.015 to 0.28 cm sec^- 1 for various gas-soil pairs. These are likely to be upper limits for dry deposition of H_2S and DMS in the environment since the laboratory results, which include X-ray photoelectron spectroscopy (ESCA) experiments, suggest that the observed deposition velocities are due primarily to reversible physical adsorption. Irreversible surface reactions leading to permanent removal of H_2S and DMS are much slower. Quantitative estimates of dry deposition of these species, in conjunction with relevant results from the literature, suggest this process is unlikely to be environmentally important for H_2S and DMS.

1338 Long path measurements of atmospheric sulphur dioxide by a Barringer Cospec III. Sandroni, S.; Ceruth, C. (Joint Nuclear Research Center, Ispra, Italy). *Atmos. Environ.;* **11**: No. 12, 1225-1232(1977).

Time fluctuations of ground level concentrations of atmospheric sulphur dioxide have been successfully measured over distances of up to 1 km, using a Cospec III (Barringer Research, Canada) aligned on a modulated xenon lamp. Experiments have been carried out on hills at Ispra, at Milan airport, near a large refinery (Lacq, France) and around a power station (Drax, England) at heights from 1.7 to 30 m above the ground. Using an artificial light source, measurements can be made over a 24 hr period, and under non-ideal meteorological conditions (rain, haze, etc.). The detection limit is 5 ppb over a 1 km path. The agreement of average long path data between the remote sensor and point samplers is quite satisfactory. Long path measurements can be applied to air quality measurements in urban areas as well as to monitoring and modelling the pollutant diffusion and fall-out around a plant.

1339 Isotopic composition of ammonia, nitrogen dioxide and nitrate in the atmosphere. Moore, H. (Florida International Univ., Miami). *Atmos. Environ.;* **11**: No. 12, 1239-1243(1977).

Values of nitrogen isotope ratios in gaseous ammonia and nitrogen dioxide and in ammonium ion and nitrate ion in aerosols and precipitation are presented. These values are shown to vary with source. Ammonia in clean air samples had a delta ^{15}N of -10.0 +- 2.6‰ compared to + 24.9 +- 3.4‰ in barnyard samples. Nitrogen dioxide in clean air is -9.3 +- 3.5‰ compared to auto exhaust of +3.7 +- 0.3‰. Ammonium ion in particulates and in rain had delta ^{15}N values of 5.6 +- 5.5 and -1.4 +- 3.5‰, respectively. Nitrate ion in particulates and in rain had delta ^{15}N values of 5.0 +- 5.7 and -6.6 +- 3.9‰, respectively. Several possible isotope fractionation mechanisms which might be operative in the atmosphere are discussed. The most plausible fractionation mechanism appears to involve isotopic equilibrium between gaseous and condensed phases with subsequent removal of the condensed phase.

1340 Observations and calculations of airborne sulphur from multiple sources out to 100 km. Fisher, B.E.A. (Central Electricity Research Labs., Leatherhead, Eng.); Gotaas, Y.; Hamilton, P.M.; Houlgate, R.; Maul, P.; Moore, D.J. *Atmos. Environ.;* **11**: No. 12, 1163-1170(1977).

An exercise to investigate the mesoscale transport of SO_2 over the Midlands of England out to distances of 100 km from the main sources is described. A combination of meteorological instruments and air pollution monitors, including a ground-based lidar and a correlation spectrometer mounted in an aircraft, was used. The flight paths were planned to be crosswind of a number of large power stations in order to isolate the dispersion of material emitted at a single point. The main value of the correlation spectrometer was for this purpose. A mesoscale multi-source diffusion transport model with all its parameters derived from observations was used to relate estimated SO_2 emissions in the Midlands with the observations. Together, the observations and measurements provided a fairly complete description of mesoscale transport during dry convective conditions when there is fairly rapid mixing of SO_2 from all sources within the mixing layer. The exercise could only give a rough indication of the removal and transformation processes affecting SO_2 transport.

1341 Review of chemiluminescent techniques for air pollution monitoring. Hodgeson, J.A. (Environmental Protection Agency, Las Vegas, NV). *Toxicol. Environ. Chem. Rev.;* **2**: No. 2, 81-97(1974).

Chemiluminescent analysis of gas-phase airborne pollutants is reviewed. This tehnique is used primarily to detect ozone, nitrogen oxide, and sulfur compounds. Also discussed are methods used to detect nitrogen oxides, ammonia, carbon monoxide, and compounds of nitrogen, phosphorus, boron, and halogens.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 339, 1261, 1499

1342 (MHSMP—78-7) Environmental monitoring report for Pantex Plant covering 1977. Alexander, R.E.; Horton, C.N. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Mar 1978. Contract EY-76-C-04-0487. 55p. Dep. NTIS, PC A04/MF A01.

During 1977 Pantex Plant conducted a monitoring program to determine the concentration of specific radioactive and nonradioactive species in the local environment. Although the plant activities involve the handling of significant quantities of uranium, plutonium, and tritium, only small releases of uranium (depleted in the isotope ^{235}U) and tritium occurred which could have affected the local environment. Monitoring data indicate that concentrations of these nuclides in the environment are below established criteria for air and water and therefore should not present a health hazard either to employees or to the public. Nonradioactive emissions were also well below prescribed standards and constituted no health hazard.

1343 Workshop on methods for measuring radiation in around uranium mills. Volume 3, No. 9. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977). 434p. (CONF-770581—). $20.00.

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Separate abstracts were prepared for 22 papers presented. An abstract of one paper appeared in ERA previously.

1344 State review of environmental aspects of uranium mill operations. Siek, R.D. (Colorado Dept. of Health, Denver). pp 3-8 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Programs of the State of Colorado initiated in 1957 for investigating environmental problems and health hazards associated with the disposal of uranium mill tailings are reviewed. Emphasis is placed on health hazards resulting from the use of mill tailings in building materials that resulted in the exposure of human populations to external γ and inhalation exposure to radon daughter products. The remedial action program for Grand Junction, where 200 occupied structures were constructed on or with mill tailings, cost an average of $63/rem annual dose reduction, for a total cost of $3,316,097. It is recommended that in the future development of uranium mills the developers make financial arrangements to assure the stabilization and isolation of mill tailings with perpetual surveillance and maintenance of mill tailings disposal sites.

1345 Environmental Protection Agency: review of environmental aspects of uranium mill operations. Hendricks, D.W. (Environmental Protection Agency, Las Vegas, NV). pp 9-14 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

The preparation of a data base for the various segments of the uranium fuel cycle to assure the protection of the environment and the public health is discussed. Emphasis is placed on radiation protection standards applicable to uranium mills and mill tailings to become effective in December, 1980. Studies on active and inactive uranium mill sites are underway to assist in the preparation of standards that will be cost effective. These standards will be of value in the preparation of proposals for the construction of additional uranium mills and in the preparation of pre-construction environmental impact statements.

1346 Inactive uranium millsites and tailings piles program. McGinley, F.E.; Haldane, W.E. (Energy Research and Development Administration, Grand Junction, CO). pp 15-34 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Progress is reported on a survey of 22 inactive uranium mill sites and mill tailings disposal areas to determine site conditions and environmental factors contributing to health hazards to the general population. The findings will be used to suggest remedial action measures and to prepare cost estimates for alternative remedial actions. The criteria for remedial action are summarized. Efforts were made to quantify the major potential routes of radiation exposure to man including: radon diffusion, external γ, airborne activity, water contamination, subsoil contamination, food chain contamination, and physical removal. The inhalation of radon daughters was considered the most significant health hazard and the food chain pathway the least health hazard.

1347 Current uranium mill licensing issues. Scarano, R.A. (Nuclear Regulatory Commission, Washington, DC). pp 35-51 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

The problems encountered to insure environmentally safe mining and milling of uranium ores are reviewed. Emphasis is placed on the management of tailings resulting from milling operations. It is pointed out that although the concentration of radioactivity in the tailings is relatively low, control measures are necessary because of the large quantities involved and because of the long half-life of the parent radionuclides present. The major concerns with mill tailings are radon release to the atmosphere and isolation of the tailings from the human environment. Since it is anticipated that the amount of tailings created by the year 2000 will be more than an order of magnitude greater than the quantities that have been generated during the past 30 years, it is recommended that all mill tailings storage areas be located remote from public contact and in areas such that disruption and dispersion by natural forces and seepage of toxic materials into ground water systems are reduced to the maximum extent achievable. Technical issues that receive attention during the NRC licensing process for uranium mills and the preparation of environmental impact statements are discussed briefly.

1348 Review of environmental aspects of uranium mill operations: industry's view. Beverly, R.G. pp 53-59 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Problems faced by uranium mill operators in complying with new environmental regulations and guidelines are discussed. It is pointed out that valid data must be available in order to evaluate impacts on the environment, to determine background radiation levels, to measure the effectiveness of control techniques, and to determine compliance with standards and regulations. Specific problem areas facing mill operators today and some of the unresolved questions include: sampling methods and equipment for radon in ambient air, measurements of radon and radon daughter exposures of people, radon emanation rate meaurements applicable to monitoring mill tailings, the calibration of γ counters, measurements of population doses, regulations concerning mill tailings reclamation nd stabilization, and the comparative value of in-vivo counting and uranium urinary excretion measurements for monitoring personnel.

1349 Union Carbide's radiation monitoring program in and around uranium mills. Fiorillo, J.M. pp 61-68 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Radiation monitoring programs in and around operating uranium mills are discussed. Sampling time periods varying from monthly to annually include airborne particulates and ^{222}Rn daughters, radionuclides in liquid effluents and drinking water, soils, and plants, and the analysis of urine from mill personnel for uranium content. Measurements are also made of natural uranium, ^{230}Th, ^{226}Ra, ^{210}Pb and daughters, and γ activity in working areas. It is pointed out that ^{222}Rn measurements are considered unnecessary for occupational exposure since annually averaged ^{222}Rn daughter concentrations expressed in working level(WL) units are an acceptable equivalent. Equilibrium data for ^{210}Pb and daughters indicate that the maximum permissible concentration (MPC) has not been exceeded. The importance of sampling locations and the reliability of monitoring instruments is stressed. Public health considerations in the selection of sites for uranium mills are reviewed briefly.

1350 Alpha scintillation radon counting. Lucas, H.F. Jr. (Argonne National Lab., IL). pp 69-95 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

The principles affecting alpha-scintillation radon counting chamber design are discussed. An analytical system suitable for a large scale study of the ^{222}Rn and ^{226}Ra content of either air or other environmental samples is described. Factors that affect the accuracy and precision of the method are pointed out.

1351 Integrating air sampler for determination of ^{222}Rn. Sill, C.W. (Atomic Energy Commission, Idaho Falls, ID). pp 97-104 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

The actual radiological hazard from radon emitted from tailings piles remaining from processing uranium ores is extremely difficult to assess. Exhalation of radon from the ground varies markedly with time and is particularly dependent on the condition of the surface and the prevailing meteorological conditions. Using present techniques, the sampling required to permit a realistic estimate of the dose sustained by a significant population in a year's time is economically prohibitive. A sampler has been developed to collect air continuously at 10 ml/min for 48 hr to provide an integrated sample which can be analyzed to determine the average ^{222}Rn concentration to which people at that location were exposed during the same period of time. A small aquarium aerator pumps filtered air through a precision needle valve with a digital indicating handle into a collapsible 40 l bag made of laminated $^{3}/_{4}$ mil Mylar. The pump can be used either directly from an ac line or from a battery with a small power inverter. Each station is resampled at 3-week intervals for a calendar year, amounting to approximately 10% of the total time available.

1352 Measurements of environmental radon with integrating instruments. George, A.C.; Breslin, A.J. (Energy Research and Development Administration, New York). pp 105-115 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Two monitoring instruments have been developed for the measurement of average environmental radon concentration in a period of a week or longer. Both employ thermoluminescent lithium fluoride chips for detection and both weigh about 5 kg. One instrument is based on the two-filter method for ^{222}Rn determination. Air is drawn continuously through the two-filter tube at a rate of 3 l/min by a personal sampler pump that operates on line power or a storage battery. The lithium fluoride chip is positioned a short distance from the surface of the second filter. The lower limit of detection is .05 pCi/l in one week. The instrument can be fabricated at an approximate cost of $800. The other instrument is entirely passive in operation. Polonium-218 ions are collected electrostatically on the lithium fluoride detector from a sensitive volume into which radon diffuses through a porous barrier from ambient air. The lower limit of detection is 0.03 pCi/l in one week. Construction is simple, utilizing commonly available components that cost about $50.

1353 Design and application of a continuous, digital-readout, radon measuring instrument. Wrenn, M.E.; Spitz, H.B. (New York Univ. Medical Center, NY). pp 117-129 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

A continuous radon measuring instrument was designed and fabricated in response to a need for a rapid and simple method for analyzing the atmosphere in residential structures that were believed to have uranium mill tailings incorporated into the building materials. Radon concentrations in some of these houses are not elevated above normal average indoor background values. With the current interest in keeping radiation exposures to the lowest practicable level for the general population, a need has arisen for monitoring instruments that are capable of measuring environmental levels of natural radioactivity. Meaurements of radon in the environment are not routinely available on a continuous basis but are made using grab sampling techniques which necessarily result in a discontinuous supply of information by virtue of the method of measurement. A limited number of grab samples are usually inadequate to characterize the radon levels because of the large diurnal effect observed. The successful employment of the NYU continuous, digital-readout radon monitoring instrument in Grand Junction has indicated that the unit can operate for extended periods of time without the need of operator assistance. The application of these instruments to the environmental monitoring programs around uranium mines and mills is evident.

1354 Measurement of radon flux by the accumulation method. Wilkening, M. (New Mexico Inst. of Mining and Tech., Socorro). pp 131-138 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Radon flux is the net rate of transfer of ^{222}Rn atoms across a specified boundary, usually from soil or other surface to air. It is commonly expressed in units of radon atoms (or picocuries) per square meter and second. Radon and radon-daughter concentrations give information from which dose or physiological effects can be determined; radon flux gives us information concerning the source, whether it be the earth's surface, a working face in a mine, or a tailings pile. An accumulator device is described that measures changes in the concentration of ^{222}Rn over a surface with time.

1355 Measurement of ^{222}Rn flux with charcoal canisters. Countess, R.J. (Energy Research and Development Administration, New York). pp 139-156 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

A new method for determining the rate of ^{222}Rn (radon) emanation from a surface is described. A modified U.S. Army M11 gas mask canister containing activated charcoal is sealed to the surface for several hours to several days, depending on the anticipated flux. The amount of radon adsorbed in the charcoal canister is determined by counting gamma emission from radon daughters in equilibrium with the radon. Details of the canister calibration and the parameters that affect the measurements of radon flux using activated charcoal canisters are described.

1356 Grab sampling: methods and interpretation. Tappan, J.T. (Combustion Engineering, Inc., Grand Junction, CO). pp 157-174 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

A relatively prompt technique for measuring average concentrations of ^{222}Rn and radon daughters inside occupied areas has been developed. A combination of scintillation cell (radon) samples and filtered high volume air samples (radon daughter) are collected in sets throughout the area at times when various structure use and ventilation conditions exist. These samples are analyzed, time weighted for each variable condition, and averaged. Additionally, the maximum concentration and the radon/radon daughter equilibrium state is measured thereby providing data to facilitate evaluation of potential exposure and the relative age of the radon. Accumulated data indicates this technique is a reliable screening tool in determining the need for remedial measures and/or additional long term integrated sampling to further evaluate concentrations ranging near the exposure guide criteria.

1357 Integrated working level samplers using thermoluminescent dosimeters: operation and interpretation. Franz, G.A.; Peterson, B.; Langner, H.L.; Thornberg, C. (Colorado Dept. of Health, Denver). pp 175-180 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Colorado's early experience in measuring ^{222}Rn daughters with grab samples inside structures showed that there was a wide variation in radon daughter concentration (RDC) from minute to minute, because of ventilation and condensation nuclei changes, and hour-to-hour or day-to-day changes because of passing weather conditions. Additionally, the overall changing conditions in all of the above from season to season of the year produced substantial differences in RDC. It was possible to reduce the measured RDC in a structure by a factor of 20 or 30 simply by opening an outside door for a few minutes, and then build back within a half-hour. The measured levels of RDC jump dramatically (from one sample to another) by burning a cigarette in the previously smoke-free and relatively dust-free room. An evaporative type air conditioner, pumping large volumes of air through a structure during the summer months, could decrease RDC by a factor of 100 to 200 as compared to levels in winter when the structure was relatively tightly closed. Because of this wide variation of measured RDC, it was decided to take two week-long integrated samples, which would integrate most of the hour-to-hour and day-to-day variables. Additionally, six evenly spaced samples over a period of one year would give a better estimate of an annual average exposure, thus integrating the climatic changes and ventilation changes occurring from season to season. A sampling device that could measure background levels of RDC (approximately .007 WL) and also measure levels in excess of 1 WL, and integrate and store RDC information for later retrieval was developed. The design and performance of this radon progeny integrating sampling unit (RPISU) using thermoluminescent dosemeters are discussed.

1358 Evaluation of various radon daughter measurement methods. Holub, R.F.; Droullard, R.F. (Bureau of Mines, Denver). pp 197-220 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

The advantages and disadvantages of eight commonly used methods of measuring ^{222}Rn daughter product concentrations in air are discussed. Methods used to evaluate the methods are described.

1359 Gamma radiation surveys around uranium mill tailing piles. Hans, J.M. Jr. (Environmental Protection Agency, Las Vegas, NV). pp 275-292 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Wind and water erosion of uranium mill tailings over large areas have been observed at both active and inactive uranium mill sites. A technique for assessing the γ activity of off-pile tailings is described. Any suitable instrumentation, other than those described in the report, may be used if properly calibrated. Knowledge of the extent of eroded tailings is necessary to check stabilization effectiveness and to document or identify potential exposures as well as for present and future compliance purposes.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

1360 Mathematical modeling of particulate thermal coagulation and transport downstream of an urban area source. Sheih, C.M. (Argonne National Lab., IL). *Atmos. Environ.;* **11**: No. 12, 1185-1190(1977).

A finite-difference model incorporating the mechanisms of thermal coagulation and gravitational sedimentation in the equation of diffusion is used to predict the particulate size distribution downstream from an urban area source. The particulate size range is 0.001 to 100 μm dia and the domain is 1 km vertically and 100 x 80 km horizontally in the mean and cross-wind directions, respectively. The predicted particulate concentrations, coagulation rate and deposition rate are presented. Comparison between the cases without particles larger than 10 μm and with all the particles included shows that the larger particles serve as an efficient collection agent for the particles smaller than 0.05 μm. The predicted spectral shape simulates fairly well the observations by Whitby et al. and Junge in the range smaller than 0.1 μm, and appears closer to Deirmendjian's observations in the range of 0.1 to 1.0 μm. The effect of gravitational sedimentation and coagulation is found to be negligible for particles in the range of 0.1 to 1 μm. Consequently, the number spectrum should peak at this range in an equilibrium state.

SITE RESOURCE AND USE STUDIES

1361 (CONF-780147—1) Management of diverse environmental data with SAS. Olson, R.J.; Strand, R.H. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From 3. conference of the SAS users group; Las Vegas, NV, USA (30 Jan 1978).

Environmental assessment and planning for energy development require rapid access to data at appropriate spatial and temporal scales. In the Environmental Sciences Division at Oak Ridge National Laboratory, we have developed a spatial data base at the county-subcounty level of resolution. The data base contains information on terrain, water resources, forestry, agriculture, land use, wildlife, air quality, climate, critical natural areas, human population, health, and energy. Each of these subject sectors is stored as a SAS data set. The SAS directory is used extensively to describe the 800 variables contained in the present 30 data sets. The file currently occupies 10 million bytes of storage for a 16 state area in the southeastern United States. The data base is unique in that it was compiled from many existing data sources into a single, standardized file for a large geographic area. The data base is being used, for example, to study habitat relations and population dynamics of wildlife, potential changes in vegetation patterns related to predicted climate shifts from increased atmospheric CO_2, and regional energy facility impact assessment and siting.

REGULATIONS

REFER ALSO TO CITATION(S) 822

1362 Problem of equity in emission offsets. McKee, H.C. (City of Houston Health Dept., TX). *J. Air Pollut. Control Assoc.;* **28**: No. 6, 602-603(Jun 1978).

Potential inequities in the emission offset policy of the Environmental Protection Agency are discussed. It is shown that areas which had relatively strict pollution abatement programs before their baseline was set have relatively less potential reduction to allow for growth than areas which had less strict programs. This inequity could impose severe economic penalties on those areas which had aggressive pollution abatement programs prior to the Clean Air Act of 1977.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

REFER ALSO TO CITATION(S) 820

BASIC STUDIES

REFER ALSO TO CITATION(S) 1306, 1307

1363 CERES: a model of forest stand biomass dynamics for predicting trace contaminant, nutrient, and water effects. I. Model description. Dixon, K.R.; Luxmoore, R.J.; Begovich, C.L. (Oak Ridge National Lab., TN). *Ecol. Model.;* **5**: No. 1, 17-38(Jun 1978).

CERES is a forest stand growth model which incorporates sugar transport in order to predict both short-term effects and long-term accumulation of trace contaminants and/or nutrients when coupled with the soil chemistry model (SCHEM), and models of solute uptake (DIFMAS and DRYADS) of the Unified Transport Model, UTM. An important feature of CERES is its ability to interface with the soil—plant—atmosphere water model (PROSPER) as a means of both predicting and studying the effects of plant water status on growth and solute transport. CERES considers the biomass dynamics of plants, standing dead and litter with plants divided into leaves, stems, roots, and fruits. The plant parts are divided further into sugar substrate, storage, and in the case of stems and roots, heartwood components. Each ecosystem omponent is described by a mass balance equation written as a first-order ordinary differential equation.

1364 Spectral analysis of forest model time series. Emanuel, W.R.; West, D.C.; Shugart, H.H. Jr. (Oak Ridge National Lab., TN). *Ecol. Model.;* **4**: No. 4, 313-326(May 1978).

The use of spectral analysis to elucidate the cyclic behavior in time series generated by a forest stand growth simulation model is discussed. A stand-level simulator, FORET, for an Appalachian deciduous forest is described. An estimate of the power spectral density of the total biomass time series is calculated. The power spectral density estimate indicates a dominant cyclic behavior with a period of about 200 years. In addition the spectral density is approximately bandlimited. This characteristic makes possible the application of the sampling theorem for analysis of sampling rates.

1365 Microhabitats in a forest-floor small mammal fauna. Dueser, R.D. (Univ. of Michigan, Ann Arbor); Shugart, H.H. Jr. *Ecology;* **59**: No. 1, 89-98(Win 1978).

This study examines microhabitat configurations for 3 small mammal species occupying second-growth mesic forest on Walker Branch Watershed in eastern Tennessee. Small mammal populations were sampled in oak—hickory, chestnut oak and pine forest types, with three 0.36-ha live-trapping grids per forest type. There were 255 total captures for 4 forest-floor species during 9,696 trap nights between 1 May and 16 August 1973. These captures included 2% Blarina brevicauda, 66% Peromyscus leucopus, 5% Ochrotomys nuttalli and 27% Tamias striatus. Blarina was captured most frequently in the pine forest type. Peromyscus and Tamias most frequently in the oak—hickory, and Ochrotomys exclusively in the pine. Twenty-nine variables describing proximate habitat structure were measured at each small mammal capture site. There were significant overall species differences on 18 of these variables. A subset of variables was identified for each of the 3 most frequently observed species, consisting of only the variables of particular significance for distinguishing the capture sites of that species from those of the other species collectively. Discriminant analysis of these few variables both described the average microhabitat configuration for a species and indicated the relative importance of each variable for characterizing or describing that configuration, subject to the assumptions of the analysis. The observed differences between species in microhabitat configuration are consistent with both the composition by forest type of each species sample and the literature information for each species. Microhabitat segregation among these species is discussed with reference to recent theories of habitat selection, ecological specialization and resource partitioning in equilibrium faunas.

1366 Some sampling properties of the Fager index for recurrent species groups. Hayes, W.B. (Univ. of Georgia, Athens). *Ecology;* **59**: No. 1, 194-196(Win 1978).

A Monte Carlo technique was used to produce sets of samples from a series of artificial 2-species communities. The Fager "recurrent group" index was calculated for these samples. The effects of sample numbers were assessed by comparing the sample indices to size-corrected population index values. A small negative bias was noted for indices calculated from the smaller sample sets, particularly in those communities where the species were rare. The index appears to give conservative estimates of affinity when only a small number of samples are taken.

1367 Weibull distribution: a new method of summarizing survivorship data. Pinder, J.E. III.; Wiener, J.G.; Smith, M.H. (Savannah River Ecology Lab., Aiken, SC). *Ecology;* **59**: No. 1, 175-179(Win 1978).

Survivorship data can be effectively summarized using the shape and scale parameters of the Weibull frequency distribution. The shape parameter controls the rate of change of the age-specific mortality rate and, therefore, the general form of the survivorship curve. Estimates of shape and scale parameters and their confidence intervals can be easily calculated and used to compare survivorship curves of different populations.

1368 Seasonal nutrient dynamics in the vegetation on a southern Appalachian watershed. Day, F.P. Jr.; Monk, C.D. (Univ. of Georgia, Athens). *Am. J. Bot.;* **64**: No. 9, 1126-1139(Oct 1977).

Nutrient dynamics in vegetation play an important role in determining the circulation and storage of nutrients in an ecosystem. The major objectives of this study were to estimate the plant nutrient pools (K, Ca, Mg, and Na) on a hardwood forest watershed at Coweeta Hydrologic Laboratory, North Carolina, on a seasonal basis and to relate any observed trends to seasonal productivity and phenology. Late-summer nutrient standing crops in the vegetation were calculated to be 551 kg/ha Ca, 233 kg/ha K, 48 kg/ha Mg, and 48 kg/ha Na. Nitrogen, P, and K concentrations in the leaves decreased seasonally, whereas Ca concentrations increased and Mg and Na concentrations remained relatively constant. Nutrient concentrations in the woody portion of the plants remained relatively constant. Standing crops of all nutrients increased seasonally with slight decreases of N and K in the leaves in the fall. Major conclusions of the study were (1) individual species and different plant components have nutrient storage-pool turnover times ranging from one year to several hundred years. Canopy species are important in long and short term nutrient cycles; nutrient-rich understory species such as Cornus florida are important in the annual cycle; and evergreen species are important in cycles of intermediate length because of nutrient storage in their perennial leaves. (2) Even though most of the annual nutrient uptake is recycled the same season (92, 79, 93, and 68% of K, Ca, Mg, and Na uptake, respectively), the total accumulation of nutrients is considerable in a mature forest stand.

1369 Net primary production and phenology on a southern Appalachian watershed. Day, F.P. Jr.; Monk, C.D. (Univ. of Georgia, Athens). *Am. J. Bot.;* **64**: No. 9, 1117-1125(Oct 1977).

Net primary production (NPP) is an important function of plant communities which has not often been examined seasonally in a forested ecosystem. The major objective of the study was to measure above-ground NPP seasonally and relate it to phenological activity on a hardwood forest watershed at Coweeta Hydrologic Laboratory, North Carolina. NPP was estimated as the increase in biomass, estimated from regression equations on diameter. Diameter increases were measured by vernier tree bands. Phenological observations were made on bud break, leaf emergence, flowering, mature fruit, leaf senescence, and leaf fall. The species studied intensively were Acer rubrum, Quercus prinus, Carya glabra, Cornus florida, and Liriodendron tulipifera. Liriodendron was found to be the most productive species per individual, but Quercus prinus was the most productive per unit ground area. The total watershed estimate of aboveground NPP was 8,754 kg ha^{-1} yr^{-1} and included 47.9% leaves, 33.2% wood, 7.8% bark, 4.8% reproductive tissues, 4.2% loss to consumers, and 2.1% twigs. Increases in leaf biomass were most rapid in the spring, but woody tissue production peaked in June and continued through August. Since leaf production peaked in the spring, the plants' photosynthetic machinery was activated early in the growing season to support woody tissue production, which followed the period of rapid leaf growth, and reproductive activity. Flowering ocurred during the leaf expansion period except for Acer rubrum, which flowered before leaf emergence. Fruit maturation occurred during late summer to early fall, when there were no additional biomass increases. Acer rubrum was an exception as its fruit matured during the period of leaf expansion.

1370 Distribution of natural gamma radiation in heterogeneous medium with cylindrical interface. Davydov, Yu.B.; Davydov, A.V.; Timonov, A.A. (Sverdlovskij Gornyj Inst. (USSR); Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Yadernoj Geofiziki i Geokhimii, Moscow (USSR)). *Izv. Vyssh. Uchebn. Zaved., Geol. Razved.;* No. 3, 96-102(Mar 1977). (In Russian).

The possibility of using the diffusion approximation method to calculate a spectral natural gamma-radiation flux in the Compton energy range, as well as an integrated flux, with due account for the level of discrimination of the registered gamma radiation has been proved. Also given is the problem of natural gamma flux distribution in a two-layer medium with a cylindrical interface with radius $r=r_0$, where the internal medium is the well and the external medium is a seam containing three-dimensional gamma sources, distributed in accordance with the $A=A(z)$ law. A mathematical solution of the diffusion equation system is given, along with diffusion parameters - versus-registered radiation energy E_i curves for ^{60}Co, ^{226}Pa and ^{137}Cr isotopes. The spectral flux saturation curves are compared for energies E_i 0.15 MeV and E_i = 0.3 MeV. Also compared are the saturation curves computed for the spectral flux of scattered gamma radiation, in an irradiation approximation. The diffusion approximation error has been estimated in calculations of the gamma flux in the radiating-absorbing medium with a cylindrical interface.

RADIOMETRIC TECHNIQUES

REFER ALSO TO CITATION(S) 1309, 1310, 1311

1371 Sequential determination of radium-226, radium-228, actinium-227, and thorium isotopes in environmental and process waste samples. Percival, D.R.; Martin, D.B. (Atomic Energy Commission, Idaho Falls, ID). pp 247-254 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

A procedure is described for the sequential determination of ^{226}Ra, ^{228}Ra, ^{227}Ac, thorium isotopes, and, in some cases, ^{231}Pa in environmental and process waste samples of 0.1 to 0.001 of the concentration guides specified by Federal regulations. The radionuclides are separated from gross sample constituents by coprecipitation with lead sulfate. Radium is separated on a small quantity of barium sulfate precipitated from a diethylenetriaminepentaacetate solution of the lead sulfate. Actinium-227 and thorium are then separated sequentially from the barium sulfate supernate by extraction into bis(2-ethylhexyl)phosphoric acid. Any one or more of the radionuclides may be excluded from the analysis by omitting certain independent steps. Over-all recoveries are 99% for radium and 95% for actinium and thorium. Accuracy, precision, and the effects of chemical and radiochemical interferences are discussed. The radionuclides ^{226}Ra, ^{228}Ra, ^{227}Ac, and ^{230}Th concentrate in uranium mill wastes.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 1337

1372 Distribution of lead in the soils and herbage of West Pembrokeshire. Wilkins, C. (Rothamsted Experimental Station, Harpenden, Eng.). *Environ. Pollut. (London);* **15**: No. 1, 23-30(Jan 1978).

Lead has been determined in top and subsoil samples from over 500 sites in West Pembrokeshire. Topsoils contain from less than 1 to 356 $\mu g\ g^{-1}$ Pb with a mean of 39 $\mu g\ g^{-1}$ Pb while subsoils contain 0 to 172 $\mu g\ g^{-1}$ Pb with a mean value of 22 $\mu g\ g^{-1}$ Pb. Lead has also been determined in herbage samples from northwest Pembrokeshire and in these, the Pb contents range from less than 1 $\mu g\ g^{-1}$ to 9 $\mu g\ g^{-1}$ but most samples contain less than 2 $\mu g\ g^{-1}$. Maximum contents of Pb were found in March when samples were taken at the same site throughout the growing season. Soil samples showed maximum Pb contents around towns but this pattern was not duplicated by herbage.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 372, 1515

1373 Fallout ^{137}Cs in cultivated and noncultivated north central United States watersheds. Ritchie, J.C.; McHenry, J.R. *J. Environ. Qual.;* **7**: No. 1, 40-44(1978).

The cesium (^{137}Cs) concentrations were measured in the soils and sediments of 14 watersheds, 7 cultivated and 7 noncultivated, in the North Central United States. The ^{137}Cs concentration in watershed soils ranged from 56 to 149 nCi/m^2, with cultivated watersheds averaging 75 nCi/m^2 and noncultivated watersheds averaging 104

nCi/m². The ^{137}Cs concentration in the reservoir sediments ranged from 74 to 1,280 nCi/m², with a mean of 676 nCi/m² for the cultivated watersheds and 365 nCi/m² for the noncultivated watersheds. The ^{137}Cs concentrations per unit area in sediments were 0.8 to 18.7 times greater than those found in the contributing watershed soils. This indicated that some ^{137}Cs is moving within the watersheds and that the reservoirs are acting as "traps" or "sinks." The factors accounting for the variation in ^{137}Cs concentration in the soils and sediments of the watersheds are (i) the erosion potential of the watershed, (ii) the sites for adsorption of ^{137}Cs, and (iii) the input of radioactivity into the watershed.

1374 (ORNL-tr—4641) **Study of the migration of radioactive elements in soils "in-place".** Bovard, P.; Grauby, A. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service d'Etudes et de Recherches sur l'Environnement; CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Service d'Etudes et Recherches sur l'Environnement). [nd]. Translation by S.D. Blalock Jr. of French paper. (CONF-621010—3). 14p. Dep. NTIS, PC A02/MF A01.

From Symposium on the retention and migration of radioactive ions in soils; Saclay, France (16 Oct 1962).

The problems of medium protection against radioactive contamination hazards have led the Commissariat a l'Energie Atomique—Service de Controle des Radiations et de Genie Radioactif to study the behavior of ions in soils. There are many theoretical researches and laboratory studies on the movement of radioelements in soil. But, with the difficulties for obtaining a similar result in field, we have developed a simple direct method of in place soil contamination. However, a principal drawback remains, the necessity to extrapolate from one or two reduced size samples to a large area. This is all the problem of sampling, which is not specific of our method. However, a choice justified by classical data, let us obtain a sufficient number of results and an accuracy which is suitable.

1375 (ORNL-tr—4643) **Physico-chemical reactions in the underground movement of radioactive isotopes.** Gailledreau, C. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Service d'Etudes et Recherches sur l'Environnement). [nd]. Translation by S.D. Blalock Jr. of French paper. (CONF-621010—4). 11p. Dep. NTIS, PC A02/MF A01.

From Symposium on the retention and migration of radioactive ions in soils; Saclay, France (16 Oct 1962).

The physico-chemical state of the radioelements moving underground can influence considerably their migration velocity. In the case of ^{90}Sr—held on by monmorillonites, apatites, activated aluminum oxide—the occurrence of electronegative colloids, sorbing selectively ^{90}Sr results in an immediate break-through of this isotope. This phenomenon has been demonstrated in the case of the calcite phosphate reaction. A high pH is generally favorable to ^{90}Sr sorption (apatite, aluminum oxide). The occurrence of Ca^{2+} ions acts very unfavorably on ^{90}Sr sorption by minerals specifics of this isotope (apatite, aluminum oxide). The same thing occurs with organic matters ^{137}Cs sorption, attributed to illitic clays, is little sensitive to the nature of the solution. Ruthenium-106 seems to move underground chiefly as a nitrosylruthenium hydroxide complex. This complex would be weakly sorbed on soil colloids by London—Van der Waals forces.

SOIL

REFER ALSO TO CITATION(S) 1349

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 1342

1376 (CONF-780631—2) **Review of biological monitoring programs at nuclear facilities.** Quintana, L.R.; Oakes, T.W.; Shank, K.E. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

From 12. conference on trace substances; Columbia, MO, USA (5 Jun 1978).

Biological monitoring programs, as well as relevant radioecological research studies, are reviewed at specific Department of Energy facilities; the program at Oak Ridge National Laboratory is discussed in detail. The biological measurements that are being used for interpreting the impact of a facility on its surrounding environment and nearby population are given. Suggestions which could facilitate interlaboratory comparison studies are presented.

1377 (LA—7162) **Further studies of long-term ecological effects of exposure to uranium.** Hanson, W.C.; Miera, F.R. Jr. (Los Alamos Scientific Lab., NM (USA)). Jul 1978. Contract W-7405-ENG-36. 33p. (AFATL-TR—78-8). Dep. NTIS, PC A02/MF A01.

Spatial variability in sampling for soil uranium distribution by a polar coordinate system was evaluated in randomly selected soil cores at the Los Alamos Scientific Laboratory. Variations for surface (0- to 2.5-cm-deep) soils were 0.18 at 10 m from the nuclear weapons test detonation point and 0.96 at 50 m. Results were strongly influenced by past uranium dispersal patterns, variable leaching of uranium debris, and surface water runoff. A total surface (0- to 5-cm) soil uranium inventory within a 12.6-ha circle centered on the E-F detonation point was estimated to be 3000 kg when calculated by soil uranium concentration isopleths and 4500 kg when using annuli of a polar coordinate sampling system. Uranium concentrations in tissues of deer mice (Peromyscus maniculatus) and pocket gophers (Thomomys bottae) were sufficiently different to conclude that the greater bioavailability of uranium in the top few millimeters of soil at E-F Site, combined with the difference in grooming and food habits of the animals, resulted in greater contamination of deer mice than of pocket gophers.

1378 **Conception for the measurement of the critical environmental exposure by radioiodine in the case of reactor accidents.** Heinemann, K.; VOGT, K.J. (KERNFORSCHUNGSANLAGE JUELICH G.M.B.H. (GERMANY, F.R.). ZENTRALABTEILUNG STRAHLENSCHUTZ). pp 447-460 of Handling of radiation accidents 1977. Vienna; International Atomic Energy Agency (1977).

From International symposium on the handling of radiation accidents; Vienna, Austria (2 Feb 1977).

On the occasion of a reactor accident, radioactive nuclides may be released into the atmosphere. By means of the diffusion calculation with realistic assumptions for the relative emission source strength of fission gases and radioiodine it is shown that, in the case of typical dispersion conditions, the inhalation of the iodine nuclides constitutes the critical exposure pathway, provided that the ingestion of contaminated food is considered avoidable. For the purpose of initiating accident prevention measures it is therefore necessary to have a precise knowledge of the inhalation dose in the locations affected. Various concepts for determining the inhalation dose are presented and discussed. It is explained why the concepts based on the diffusion calculation do not furnish sufficient information for emergency measures due to insufficient knowledge of the emission source strength and dispersion function in the case of individual emissions. The only safe approach to determining the inhalation dose is the direct measurement of the time-integrated iodine concentration in the locations affected in conjunction with remote transmission of measured values to the accident control centres. The requirements to be met by measuring devices are explained and justified, and the possible design of an iodine monitor is described.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 136, 183, 823, 1346, 1361

1379 (EGG—1183-2356(Pt.2)) **Status of endangered and threatened plant species on Nevada Test Site: a survey. Part 2. Threatened species.** Rhoads, W.A.; Cochrane, S.A.; Williams, M.P. (EG and G, Inc., Goleta, CA (USA)). May 1978. Contract EY-76-C-08-1183. 176p. Dep. NTIS, PC A09/MF A01.

This is the second of a two-part study of plant species on the Nevada Test Site (NTS) that are listed as possibly threatened or endangered by the U.S. Fish and Wildlife Service (FWS). This study was undertaken as a response by DOE to comply with the Endangered Species Act of 1973 (the Act). Part 1 treated species listed under terms of the Act as proposed endangered species. Part 2 primarily treats those species listed as threatened species candidates. Among the 15 species that grow on NTS and appeared in the Federal Register lists of candidate threatened species we report three: Astragalus funereus, Coryphantha vivipara var. rosea, and Gilia ripleyi, that should be considered as threatened. Two other species which occur on NTS and were not included on either the threatened or endangered lists should also be classified as threatened: Penstemon thurberi var. anestius and Sclerocactus polyancistrus. Of the 12 other species originally listed in the Federal Register, eight are of sufficient interest to warrant continued monitoring under a category we suggest as "Plants of Special Concern." The other four do not appear to require any protective measures or surveillance at this time. We suggest critical habitats for those species recommended for threatened status and note that some suggested critical habitats may serve for more than one species and may also include habitats for some species of special concern. Updated information about species covered in Part 1 suggests that Trifolium andersonii var. beatleyae, earlier considered endangered, should now be recommended to be removed from endangered or threatened status because of more widespread distribution than was known to us at the time Part 1 was published.

1380 (IDO—12084) **Vegetation types and surface soils of the Idaho National Engineering Laboratory site.** McBride, R.; French,

N.R.; Dahl, A.H.; Detmer, J.E. (Department of Energy, Idaho Falls, ID (USA). Idaho Operations Office). Apr 1978. Contract EY-76-C-07-1570. 36p. Dep. NTIS, PC A03/MF A01.

In 1956 the newly formed Ecology Branch of the Atomic Energy Commission's (AEC) National Reactor Testing Station (NRTS), now called the Idaho National Engineering Laboratory (INEL), under the Department of Energy, initiated a project, using aerial photos taken in 1949, 1953, and 1954 to prepare a vegetation map of the site. This area was designated a National Environmental Research Park (NERP) in 1975. The first map prepared by N. R. French and Ray McBride was produced in 1958, and differentiated vegetation types on the basis of the two most prominent species of plants occurring in each type. This map gave adequate resolution between major vegetation types only in the complex mosaic of types at the northern end of the site, designating everything else as one homogeneous vegetation classification: Artemisia tridentata (big sagebrush) and Chrysothamnus viscidifluorus (green rabbitbrush). To improve the resolution of the vegetation map and thereby make it more useful in distinguishing habitats in all parts of the site, efforts were immediately begun to reclassify the vegetation types on the basis of the three (instead of two) most prominent species of plants representative of each type. This effort was continued on a low-priority basis for several years. In 1965 a vegetation map, according to the three species designation, was prepared by Ray McBride. The map was never documented in a formal report, but was reproduced in a thesis by Harniss (1968) and was referenced by Harniss and West (1973a) in their outline of the vegetation types of the NRTS. It is the purpose of this report to document the original vegetation type map prepared by the late Ray McBride and to provide general descriptions of the different vegetation types. The map has been revised and redrawn, and is appended to this report. Because vegetation is intimately related to soil development, a preliminary soil type map prepared and discussed by Adrian H. Dahl is included in this report.

REGULATIONS

REFER ALSO TO CITATION(S) 822, 1483

ENVIRONMENTAL SCIENCES, AQUATIC

REFER ALSO TO CITATION(S) 820

BASIC STUDIES

REFER ALSO TO CITATION(S) 271, 1306, 1307, 1426, 1454, 1520

1381 Pattern analysis of Clear Lake phytoplankton. Sandusky, J.C.; Horne, A.J. (Univ. of California, Berkeley). *Limnol. Oceanogr.;* **23**: No. 4, 636-648(Jul 1978).

Using results from synoptic measurements we developed a statistical frequency distribution more suitable for aquatic plankton than existing ones. We analyzed the synoptic data with this distribution and used the results to quantify phytoplankton spatial relations and to investigate controlling physical and ecological factors. We analyzed 43 sets of data (about 32 samples per set) representing 18 freshwater phytoplankton genera and obtained reliable results using three fitted parameters per set. We explicitly separated local and regional variability, thus avoiding overestimates of regional variability (patchiness) caused by counting individual cells of colonial or locally associated species as independent units. Patchiness estimates showed significant between-species variations related to nutrient variability, relative species dominance, and species sensitivity. Pooling cell frequencies for related species reduced patchiness estimates. This implies that comparisons of spatial relations between biotic and abiotic parameters underestimate phytoplankton (biotic) spatial organization when several species are present.

1382 Wind events and food chain dynamics within the New York Bight. Walsh, J.J.; Whitledge, T.E.; Barvenik, F.W.; Wirick, C.D.; Howe, S.O. (Brookhaven National Lab., Upton, NY). *Limnol. Oceanogr.;* **23**: No. 4, 659-683(Jul 1978).

Time series of wind, current, nutrients, chlorophyll, and zooplankton are used to examine the effect of storm events on the food chain dynamics of the New York Bight. Storms cause dilution of phytoplankton concentration in the vertical plane, but lead to aggregation of chlorophyll in the horizontal field. Nutrients are made available with onshore flow in response to wind events favorable for upwelling. A series of nutrient budgets suggest that storm-induced mixing and upwelling of nitrate may satisfy at least 33 percent of the productivity demand of this system. Examples of the biological response to storms are drawn from 20 cruises during January, March, April—May, and August—September 1974, 1975, 1976, and 1977 under mixed and stratified conditions of the water column. The interaction of storms and seasonal stratification suggests predictable structure and frequency of chlorophyll distribution across the shelf which may influence both the survival strategies of herbivores and the loci of energy transfer to the rest of the food chain.

1383 Steady state growth and ammonium uptake of a fast-growing marine diatom. Goldman, J.C. (Woods Hole Oceanographic Institution, MA); McCarthy, J.J. *Limnol. Oceanogr.;* **23**: No. 4, 695-703(Jul 1978).

A fast-growing marine diatom Thalassiosira pseudonana (3H) was grown under NH_4^+-limited steady state conditions in continuous culture. Growth rate could not be described as a function of external or residual NH_4^+ because of analytical limitations in measuring NH_4^+ concentrations less than 0.03 μg-atom N liter^{-1}. Neither did the data fit the internal nutrient model of Droop because the washout growth rate (μ) under N limitation is substantially less than the maximum growth rate term used in the Droop expression (anti μ). The ratio of the minimum (k/sub Q/) to the maximum (Q/sub m/) cell quota was the key term in determining the ratio μ : anti μ, and hence the applicability of the Droop expression. For limiting nutrients such as vitamin B_{12} and P, μ approximately anti μ, and the expression is applicable; but, when μ less than anti μ, as for N and Si, the usefulness of the expression is diminished, and when anti μ → infinity, as for inorganic carbon, the Droop equation is completely invalid. In a general sense the usefulness of the Droop expression diminishes as the limiting nutrient : cell weight ratio increases. The generality of the concept of cell "shift up," or increasing k/sub Q/ and anti μ with increasing growth rate, is questioned as no evidence for this phenomenon was found in T. pseudonana. Moreover, the demonstration of discontinuities in kinetic curves of Q vs. μ does not a priori imply that the coefficients k/sub Q/ and μ are variable.

1384 Photorespiration and CO_2 compensation point in Najas flexilis. Hough, R.A. (Wayne State Univ., Detroit); Wetzel, R.G. *Limnol. Oceanogr.;* **23**: No. 4, 719-724(Jul 1978).

The response of net photosynthesis, light : dark respiration ratio, and CO_2 compensation point to oxygen manipulation and to inhibitors of glycolate metabolism confirms earlier evidence that photorespiration occurs in Najas flexilis and can influence its productivity. Estimates of the CO_2 compensation point are similar to those for several other submersed angiosperms which cannot reduce total aqueous CO_2 concentration much below air equilibrium levels.

1385 Predicting particle selection by deposit feeders: a model and its implications. Taghon, G.L.; Self, R.F.L.; Jumars, P.A. (Univ. of Washington, Seattle). *Limnol. Oceanogr.;* **23**: No. 4, 752-759(Jul 1978).

A feeding model for a generalized, benthic deposit feeder is derived from a filter-feeding model and used to predict how such a deposit feeder would adjust its feeding to maximize its net energy gain. Under the assumption that deposit feeders are utilizing the bacterial fraction of the sediment or other surface organic coatings as food, the model predicts that the smallest particles should always be ingested, while the selection of larger particles depends on several parameters, including gut passage time and assimilation efficiency of the deposit feeder. The model also predicts relationships among particle size selection, assimilation efficiency, gut passage time, gut volume, and particle rejection costs.

1386 Comparison by size, class, and volume of detritus versus phytoplankton in Chesapeake Bay. Van Valkenburg, S.D.; Jones, J.K.; Heinle, D.R. (Chesapeake Biological Lab., Solomons, MD). *Estuarine Coastal Mar. Sci.;* **6**: No. 6, 569-582(Jun 1978).

Relative numbers and sizes of detritus vs. phytoplankton particles were determined by visual counting over a period of 17 months at a mid-bay station in a temperate estuary. Detritus averaged 76.6% of total particle numbers, the phytoplankton 23.4%. Seasonal variation in detritus numbers was minimal as compared to the strong summer pulse of the phytoplankton. Detritus numbers were concentrated in the smallest size category (64.7% at 2 to 5 μm) as were the phytoplankton (55.6% at 2.5 μm). Detritus particles also overshadow the phytoplankton in total volume present, representing 65.7% of total yearly volume, the remaining 34.3% of total volume representing live cells. The peak of detritus volume determined by visual counts is at the high end (20 to 35$^+$ μm), whereas phytoplankton volume peaks at mid ranges (5$^+$—20 μm). Phytoplankton occurrence and abundance, and the percent of phytoplankton volume contributed by each taxonomic class, are also recorded.

1387 Aspects of estuarine intertidal ecology of juvenile striped mullet, Mugil cephalus, in Hawaii. Major, P.F. (Univ. of California, Santa Cruz). *Fish. Bull.;* **76**: No. 2, 299-314(Apr 1978).

Behavior and distribution of schools of young striped mullet, Mugil cephalus, were examined in the field and laboratory. Prejuvenile fish approximately 20 mm standard length leave the open ocean to enter intertidal estuarine regions, where they select the shallowest water, areas with extensive diel temperature and salinity fluctuations. At about 50 mm standard length, the mullet move into deeper intertidal waters. It is at this size that mullet are thought to have completed their metamorphosis to juveniles. In a vertical thermal gradient, fish generally <50 mm standard length selected final mean temperatures of 30.0 to 32.4°C at the salinities tested (0, 15, 34‰). In the field, they were found in water with high (34.0 to 37.2°C), often near lethal (39.0 to 42.5°C) temperatures in shallow pools with salinities of 2 to 30‰. Juveniles generally >50 mm experimentally selected final mean temperatures of 29.0°C at 34‰ salinity to 19.5°C at 0‰ salinity. In the field, fish > or = to 50 mm remained seaward of the tide line in water of lower and more uniform temperature and higher and more uniform salinity than those recorded for mullet <50 mm. Mullet <50 mm occur seasonally when there are a maximum number of low tides < or = to 0.0 mm and a minimum number of high tides > or = to 0.6 m. This allows the mullet increased time to feed undisturbed in areas where there are no predators and intraspecific and possible interspecific competitors for food and space. By the time fish reach 50 mm standard length, the tidal situation changes, allowing predators and competitors access to the shallow areas during low tide. When in the presence of predators, the schooling habit increases chances of survival for individual mullet.

1388 Sea surface temperature anomalies in the North Pacific Ocean. Reynolds, R.W. (Max-Planck-Institut fuer Meteorologie, Hamburg). *Tellus;* **30**: No. 2, 97-103(Apr 1978).

Sea surface temperature anomalies in the mid-latitude North Pacific Ocean were compared with a first-order autoregression model in which the anomalies are forced by local atmospheric white noise. The results showed that the model can explain the power spectrum of the anomalies for a little over 50% of the investigated regions, mainly in the central regions of the Pacific, but fails, not surprisingly, in regions of strong oceanographic processes.

1389 Underwater survey method for estimating submerged macrophyte population density and biomass. Sheldon, R.B.; Boylen, C.W. (Rensselaer Polytechnic Inst., Troy, NY). *Aquat. Bot.;* **4**: No. 1, 65-72(Jan 1978).

Self-contained underwater breathing apparatus (SCUBA) was used to observe 40 species of submerged aquatic macrophytes in a large freshwater lake (Lake George, N.Y.) to determine its usefulness in the rapid assessment of relative species abundance and biomass. A population density index was used to estimate population densities for each species growing between 1 and 15 m deep. The exponential scale of the index permitted the scoring of population densities from 0.01 to 5,000 plant growing points m^{-2} based upon an average observation area of 1,000 m^2. SCUBA observations as a means of estimating abundance were calibrated by collecting plant shoots with densities corresponding to each point on the scale and determining the number of shoots m^{-2} for each species present. Direct underwater observations of plant communities covering large areas yielded comprehensive data on species diversity, population density and biomass. The population density index was found to be statistically valid using 95% confidence limits and prediction intervals. When this index is used in conjunction with the average dry weight of mature shoots for each species, a useful estimation of the mature biomass for each species is possible to within an order of magnitude over a range from 0.01 to 200 g dry weight m^{-2}.

1390 Comparative macrofaunal abundance in turtlegrass (Thalassia testudinum) communities in south Florida characterized by high blade density. Brook, I.M. (Rosenstiel School of Marine and Atmospheric Science, Miami, FL). *Bull. Mar. Sci.;* **28**: No. 1, 212-217(Jan 1978).

Five Thalassia communities with high blade density (greater than 3,000 blades/m^2) were sampled by suction dredge in April 1973. Four sites were in south Biscayne Bay, and one was at Murray Key in the Everglades National Park on the southwest coast of Florida. Macrofaunal abundance ranged from 292 to 10,728 individuals/m^2. It is postulated that a high standing crop of seagrass may not be the primary determining factor in faunal abundance.

1391 Levels of metals in dock-yard sediments with particular reference to the contributions from ship-bottom paints. Bellinger, E.G. (Univ. of Manchester, Eng.); Benham, B.R. *Environ. Pollut. (London);* **15**: No. 1, 71-81(Jan 1978).

Levels of the metals copper, lead, tin and zinc have been determined in a range of ship-bottom paints by atomic absorption spectrophotometry. Copper, lead and zinc have been similarly determined in concentrated nitric acid digests and 1M ammonium acetate extracts of sediments taken from enclosed dock-basins at Liverpool, Tilbury and Manchester. At each of the dock-yards concentrations of all the metals in nitric acid extracts were elevated in the vicinity of dry-docks. These elevations are believed to be due to the presence of residues from the ship-bottom paints. The amounts of copper and zinc, which are major components of antifoulant paints, in the ammonium acetate extracts correlate closely with the levels in the nitric acid digests; lead, which is found mainly in anticorrosive and primer paints, does not. Direct toxic effects of the metals to marine organisms are considered, but are not thought to be important in view of the large dilution and dispersal capacities usually available. The possibility of organisms developing genetic resistance to heavy metals in enclosed dock-basins is discussed. It is noted that many of the dock-yard organisms are components of the ship-fouling ecosystem, so that the premature exposure to the toxins of antifoulant paints may result in the development of toxin resistance of considerable economic importance.

1392 Studies on the functional role of tintinnids in the southern California bight. I. Grazing and growth rates in laboratory cultures. Heinbokel, J.F. (Scripps Institution of Oceanography, La Jolla, California). *Mar. Biol.;* **47**: No. 2, 177-189(1978).

Five species of tintinnids, Amphorella quadrilineata (Claparede and Lachmann, 1858), Tintinnopsis cf. beroidea Stein (1867), T. cf. acuminata Daday (1887), Eutintinnus pectinis (Kofoid and Campbell, 1929), and Helicostomella subulata (Ehrenberg, 1833), were isolated from Southern California coastal waters and maintained in laboratory cultures which were used to investigate several aspects of the feeding dynamics and population growth rates of this group of planktonic ciliates. Data are most complete for the latter three species. Both E. pectinis and H. subulata displayed ingestion and growth rates which increased with increasing food concentration until a maximum rate was obtained which then remained essentially constant as food levels increased further. Maximum hourly ingestion was equivalent to approximately 10 to 20% of the body weight of the tintinnids. T. cf. acuminata showed no such maximum ingestion rate, as ingestion rates increased throughout the entire range of food concentrations used. The dependence of growth rate of T. cf. acuminata on food concentration also differed from the other species, being characterized by a broad region of maximum growth at intermediate food levels with reduced growth at both lower and higher food concentrations. Maximum observed growth rates represented doubling times of approximately 12 h for both E. pectinis and T. cf. acuminata and 24 h for H. subulata. The data suggested gross growth efficiencies exceeding 50% over much of the range of food concentrations used. No strong evidence supporting the existence of feeding thresholds or "switching" behavior was collected during these experiments, although apparently selective feeding was observed in one experiment with E. pectinis.

1393 Studies on the functional role of tintinnids in the southern California bight. II. Grazing and growth rates of field populations. Heinbokel, J.F. (Scripps Institution of Oceanography, La Jolla, California). *Mar. Biol.;* **47**: No. 2, 191-197(1978).

The feeding behavior of relatively undisturbed natural populations of tintinnids was studied in a series of experiments which utilized water samples collected in Southern California coastal waters. Dilute suspensions of corn starch were presented to the tintinnids and the rates of ingestion of this visual tracer determined after short (5 to 20 min) incubations followed by fixation in Lugol's iodine fixative. Tintinnids were observed to ingest particles of diameters up to approximately 43% of their lorica oral diameter and at rates proportional to their oral diameters. Grazing rates observed in these experiments ranged up to approximately 10 μl tintinnid^{-1} h^{-1}, and generally agreed well with the rates observed in experiments utilizing laboratory cultures of tintinnids. No significant diel periodicity in feeding rates was observed in the one study extending over a 24 h period.

1394 Seasonal distribution and changes in the nutritive quality of living, dead, and detrital fractions of Zostera marina L. Thayer, G.W.; Engel, D.W.; LaCroix, M.W. (National Marine Fisheries Service, Beaufort, NC). *J. Exp. Mar. Biol. Ecol.;* **30**: No. 2, 109-127(Nov 1977).

Samples of eelgrass, Zostera marina L., were collected monthly from December 1974 through December 1975 in a shallow embayment near Beaufort, N.C., and separated into green leaves, dead leaves, and leaf detrital material. Each component was analyzed for dry weight, organic matter, inorganic and organic carbon, nitrogen and amino compounds. The standing crop of green and dead blades reached a maximum in April through June, while detrital matter had peaks in December, April and July-September. Inorganic carbon in the three grass fractions showed seasonal variations similar to those observed for epiphytic biomass in previous years, and represented 14, 24, and 30% of the total carbon associated with the green and dead leaves and detrital fragments, respectively. Organic carbon represented a decreasing proportion of the dry weight of these three fractions on a dry weight basis while there was a significant increase in organic carbon on an ash-free weight basis in the detrital fragments relative to the dead blades. During senescence there was a loss of nitrogen from the leaves and an increase in the

nitrogen content of the organic matter of the detritus relative to the dead leaves. The latter suggests that there was microbial growth on the detritus and subsequent nitrogen immobilization from the surrounding medium. There were significant decreases of lysine, histidine, arginine, glycine, tyrosine, and glucosamine in the dead leaves relative to the detritus. The glucosamine, derived from N-acetylglucosamine, a product of murein which is a component of microbial cell walls, had a seasonal distribution similar to that of the epiphytic community and available inorganic nitrogen in the surrounding water. The relative proportions of N-acetyl-glucosamine, nitrogen and organic carbon were all higher in the fall and winter.

RADIOMETRIC TECHNIQUES

REFER ALSO TO CITATION(S) 1309, 1371

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 269, 275, 1342, 1421, 1426, 1456, 1457, 1527, 1543

1395 (BNWL-SA—6468) **Mathematical simulation of transport of kepone and kepone-laden sediments in the James River Estuary.** Onishi, Y.; Ecker, R.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). [nd]. Contract ES-76-C-06-1830. 28p. (CONF-7709144—2). Dep. NTIS, PC A03/MF A01.

From 2. Chesapeake Bay kepone conference; Easton, MD, USA (21 Sep 1977).

The progress of a mathematical simulation study concerning kepone migration in the James River Estuary between Bailey Bay and the river mouth is described. The simulation is currently underway by applying the finite element sediment and contaminant transport model, FETRA, to solve time-dependent, longitudinal and lateral distributions of sediments and kepone by taking into account sediment-kepone interaction. The FETRA code solves sediment transport for three sediment types (i.e., cohesive and noncohesive sediments, and organic materials). The model also solves kepone transport for dissolved and particulate (attached to sediments) kepone. Particulate kepone is analyzed for those adsorbed by sediment of each sediment type. The accuracy and convergence of the FETRA code were tested for simple one- and two-dimensional equations. These test results indicated excellent agreement between the computer solutions and exact analytical solutions.

1396 (COO—2185-11) **Transport and transfer rates in the waters of the Continental Shelf. Annual report.** Biscaye, P.E. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). Jul 1978. Contract EY-76-S-02-2185. 115p. Dep. NTIS, PC A06/MF A01.

The present contract year has been one of transition from an emphasis on field work and sample gathering to the predominance of sample and data analysis and the formulation of testable hypotheses concerning specific processes in the New York Bight. We have begun to understand the seasonal transition in the role of phytoplankton vs. grazing zooplankton in forming the particles on which some reactive pollutants are removed. Using natural radioactive tracers we have estimated the removal rates of reactive metals from the surface waters and these range over an order of magnitude from most rapid nearshore to least rapid over the upper continental slope. Once removed nearshore, however, these tracers, and the pollutants for which they proxy, do not remain permanently in the sediments but appear to be remobilized (probably by oxidation) during the winter and are reintroduced into the water column. Work on transport and mixing processes of pollutants which are or behave like those in solution has continued along several fronts. Hydrographic data on the structure of the water column continues to give a description of the system that is crucial to understanding geochemical and biological processes which affect pollutants. Hydrographic characterization of water masses from the data sets of cruises has resulted in hypotheses concerning the renewal of shelf water by direct exchange between shelf and upper slope water.

1397 (NP—23201) **New England Offshore Mining Environmental Study (Project NOMES). Final report.** Padan, J.W. (ed.). (Pacific Marine Environmental Lab., Seattle, WA (USA)). Apr 1977. 152p. Department of Commerce, Washington, DC.

The New England Offshore Mining Environmental Study (Project NOMES) was begun in 1972 in order to resolve the marine environmental impact uncertainties of marine mining. It was a joint study sponsored by the Commonwealth of Massachusetts and the National Oceanic and Atmospheric Administration. Plans had called for a 1-year study of baseline conditions at a sand and gravel deposit centered in Massachusetts Bay at 40°21'41" N., 70°47'41" W., followed by a period of well-monitored commercial-scale mining. Two years of post-experiment monitoring were planned to document mining-induced changes in the seafloor and water column as well as their subsequent alteration by natural processes. The project was terminated in July 1973 as a result of the failure of the Commonwealth to arrange for a suitable site for the disposal of the three-quarters of a million cubic meters of sand and gravel to be mined during the planned spring 1974 test. Nevertheless, all principal investigators were funded through a project wrap-up phase, and two were funded long enough to permit them to study baseline conditions in two important aspects of marine life (i.e., benthos, phytoplankton) for a full year. Over 650 species of benthic invertebrates were sampled at a number of stations and natural veriability was documented. The chemical composition of seawater, sediments, and core drillings was measured.

1398 (NUREG—0468) **Investigation and analysis of a mass mortality of commercial lobsters (Homarus americanus) in Seabrook Harbor, New Hampshire during October of 1977.** Hickey, C.R. Jr. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Jun 1978. 104p. NTIS $6.50.

During latter October 1977, a mass mortality of commercially held lobsters occurred in Seabrook Harbor, New Hampshire, at a location approximately 400-600 feet south of a construction project associated with Seabrook Station. The incident was investigated by the USNRC, with cooperative effort from other federal and several state agencies. Based upon interviews with affected lobstermen, their losses are estimated to total 2372-3440 lobsters, weighing 2965-3440 pounds, the worth between $5100-$10,320. One individual lobsterman could have incurred a loss as great as $4333. Turbidity and siltation from construction activities were alleged to have been the cause of the incident, but no direct relationship between construction and the mortality could be positively confirmed. Extreme natural environmental conditions, preceeding the mortality, combined with a confirmed presence of gaffkemia (red tail disease) in an adequately dense and confined lobster stock appear to have been responsible. The gaffkemia pathogen could have originated from any one of several possible sources, and its presence coincident with construction activities suggests a correlation between the two, but none could be proven. A delay in reporting of the incident to the USNRC, few available specimens, and a paucity of environmental data hampered the investigative efforts.

1399 **Simulation model for lead movement in a watershed.** Wheeler, G.L.; Rolfe, G.L.; Reinbold, K.A. (Univ. of Illinois, Urbana). *Ecol. Model.;* **5**: No. 1, 67-76(Jun 1978).

A simulation model of the movement and accumulation of automotively emitted lead in a watershed of Central Illinois is presented. The model is composed of four parallel terrestrial subsystems or zones based on traffic volume and an aquatic system in series. The model is used to estimate historical accumulations of lead within the watershed and to compare different scenarios of reductions of lead emissions. Since the introduction of leaded gasoline an estimated 570,000 kg of lead has been emitted in the watershed. Of this total about 36% remained airborne and left the watershed, and 3% left the watershed via the aquatic system. Lead is found to be a significant pollutant in urban areas and near major highways. Without emission controls lead is expected to cause environmental problems after about 25 years.

1400 **Benthic hydrocarbons of Rhode Island Sound.** Boehm, P.D.; Quinn, J.G. (Univ. of Rhode Island, Kingston). *Estuarine Coastal Mar. Sci.;* **6**: No. 5, 471-494(May 1978).

The hydrocarbon content of surface sediments, sediment cores and quahogs (Arctica islandica) from Rhode Island Sound have been determined. Concentrations in surface sediments range from 1.0 to 56.1 μg/g, depending on sediment type and sedimentation rates. However, concentrations up to 301 μg/g are observed in surface samples from a dredge spoil deposit in the study area. Based on qualitative and quantitative hydrocarbon distributions in sediments, the hydrocarbon to organic carbon ratio, and the ratio of the concentration of a prominent cycloalkene compound to organic carbon, the normal hydrocarbon geochemistry of the region is defined. Using these criteria, the effect of dredge spoil deposit (5 to 20 x 10^3 metric tons of hydrocarbons) is insignificant beyond 2 km from the disposal site. Hydrocarbon contents of the quahog do not reflect sediment distributions qualitatively or quantitatively. The clams' hydrocarbon contents vary by 2.5 (2.6 to 6.4 μg/g wet); sediment concentrations vary by two orders of magnitude. The hydrocarbon assemblage has a lower boiling point distribution than that in sediments. Key components of surface sediments are cycloalkenes of molecular weight 344 and 348. Their concentration varies significantly with the organic carbon content of the sediment. A major component of Arctica is another related cycloalkene of molecular weight 342 and not present in the sediment. A sediment core shows a decreasing concentration of hydrocarbons and a decreasing percentage of unresolved components (UCM) with increasing depth. It is proposed that the rapid increase in the quantity of the UCM observed at a certain depth within the sediment, can serve as a chemical marker in the recent sedimentary record. This marker

corresponds to the increased usage of petroleum products at the end of the 19th century.

1401 Analytical acceptability of trace metal levels found in oceanic waters around Australia. de Forest, A.; Pettis, R.W.; Fabris, G. (Materials Research Labs., Victoria, Australia). *Aust. J. Mar. Freshwater Res.;* **29**: No. 2, 193-204(Apr 1978).

Vertical profiles of trace metal levels in the water column for 16 oceanographic stations around Tasmania were determined using anodic stripping voltammetry (ASV) at a mercury-coated graphite electrode (MCGE), a rotating disc glassy carbon electrode (RDGCE) and atomic absorption spectrophotometry (AAS). Cadmium, copper, lead, and zinc were determined by ASV, and iron and nickel were determined by AAS. Variation occurred between MCGE and RDGCE results in the samples analysed for cadmium, copper, lead, and zinc. Statistical analyses of the concentrations found indicated that variations were more likely to be due to procedural blank fluctuations than to change in concentration with depth. For the AAS analyses of nickel, some variation in concentration with depth was apparent after consideration of procedural blanks. However, this variation follows a random scatter pattern.

1402 Distribution of some heavy metals in the Gulf of Fos. Benon, P.; Blanc, F.; Bourgade, B.; David, P.; Kantin, R.; Leveau, M.; Romano, J.C.; Sautriot, D. (Centre Universitaire de Marseille-Luminy, France). *Mar. Pollut. Bull.;* **8**: No. 3, 71-75(Mar 1978).

Concentrations of copper, lead, cadmium and zinc were determined using the differential pulse anodic stripping voltametry technique in a marine industrialized area, the Gulf of Fos, near Marseilles. Results show an important contamination of the whole area, with particularly high values near the coast. Comparing our results with those of the literature, we see that the Gulf of Fos is probably one of the most polluted areas in Europe.

1403 Rapid field method for detecting oil in sediments. Brown, L.R. (Mississippi State Univ., Mississippi State); Pabst, G.S.; Light, M. *Mar. Pollut. Bull.;* **8**: No. 3, 81-82(Mar 1978).

A rapid thin-layer chromatographic technique for estimating the relative concentration of crude oil in sediments has been developed. The limit of detection on the chromatogram is 2 μg of Empire Mix or Saudi Arabian crude oil. The technique has been tested on 335 sediment samples collected from 67 stations in the Gulf of Mexico and has been utilized in assessing the location of oil entering the sediments from the Argo Merchant spill incident.

1404 Methane, carbon dioxide, and hydrogen sulfide production from the terminal methiol group of methionine by anaerobic lake sediments. Zinder, S.H.; Brock, T.D. (Univ. of Wisconsin, Madison). *Appl. Environ. Microbiol.;* **35**: No. 2, 344-352(Feb 1978).

A significant portion of the sulfide in lake sediments may be derived from sulfur-containing amino acids. Methionine degradation in Lake Mendota (Wisconsin) sediments was studied with gas chromatographic and radiotracer techniques. Temperature optimum and inhibitor studies showed that this process was biological. Methane thiol and dimethyl sulfide were produced in sediments when 1-μmol/ml unlabeled methionine was added. When chloroform (an inhibitor of one-carbon metabolism) was added to the sediments, methane thiol, carbon disulfide, and n-propane thiol were produced, even when no methionine was added. When ^{35}S-labeled methionine was added to the sediments in tracer quantities (1.75 nmol/ml), labeled hydrogen sulfide was produced, and a roughly equal amount of label was incorporated into insoluble material. Methane and carbon dioxide were produced from [methyl-^{14}C]methionine. Evidence is given favoring methane thiol as an intermediate in the formation of methane, carbon dioxide, and hydrogen sulfide from the terminal methiol group of methionine. Methionine may be an important source of sulfide in lake sediments.

1405 Estimation of aromatic hydrocarbons in seawater at proposed deepwater port (DWP) sites in the Gulf of Mexico. Hiltabrand, R.R. (Coast Guard Research and Development Center, Groton, CT). *Mar. Pollut. Bull.;* **9**: No. 1, 19-21(Jan 1978).

Approximately 100 water samples were collected from three different depths at the proposed deep water port sites in the Gulf of Mexico and analysed for aromatic hydrocarbons by fluorescence spectroscopy. Results indicated that the aromatic hydrocarbon concentrations in the water column decreased as one progresses from the surface water, through the water column, to the bottom sediments.

1406 Metals in an acid mine stream and estuary. Foster, P. (Marine Science Labs., Gwynedd, Wales); Hunt, D.T.E.; Morris, A.W. *Sci. Total Environ.;* **9**: No. 1, 75-86(Jan 1978).

Data on the concentrations of selected metals in the waters and sediments of an acid mine stream and its estuary are reported. The river water at the mouth is enriched in zinc, copper and manganese by at least two orders of magnitude above normal river water concentrations after having been significantly diluted by non-metalliferous tributaries. Iron is precipitated along the length of the stream while losses of copper and zinc from solution occur by adsorption onto hydrated ferric oxide above pH values of 4.5 and 6, respectively. Manganese concentrations are affected solely by dilution. The dissipation of the metalliferous river water in the marine regime is restricted, giving rise to estuarine waters containing high concentrations of copper and zinc both in solution and hydrogenous suspension. Deposition of hydrogenous material within the estuary is small, but approximately 50% of the zinc and 90% of the copper in the sediment is in a potentially mobile form. The environment is an unsuitable habitat for all but a few organisms.

1407 Chelation of cadmium with NTA in seawater as a model for the typical behaviour of trace heavy metal chelates in natural waters. Raspor, B.; Valenta, P.; Nuernberg, H.W.; Branica, M. (Inst. for Applied Physical Chemistry, Juelich, Ger.). *Sci. Total Environ.;* **9**: No. 1, 87-109(Jan 1978).

As a typical example for chelates of heavy metal traces in sea water, the chelation of toxic metal cadmium with the potential pollutant nitrilotriacetic acid (NTA) as ligand at the low Cd(II) concentration of 10^{-7} M and less, realistic for polluted waters, has been studied by differential pulse polarography. Detailed investigations with model solutions of singular macro-salt-components of sea water, with artificial and with natural sea water from the Adriatic have revealed the specific influences of the significant relevant macro-components of sea water on the stability of heavy metal chelates in the sea in principle, and on the chelation of Cd(II) with NTA in particular. From the methodological aspect the approach described is generally applicable to the study of other chelates with heavy metal traces in sea water and inland waters. The distribution of Cd(II) over various chemical species to be expected in sea water in the presence of given amounts of NTA has been evaluated.

1408 Report on copper and freshwater fish. *Water Res.;* **12**: No. 4, 277-280(1978).

Copper is a common pollutant in surface waters; its toxicity is largely due to Cu^{2+} which is readily complexed by both inorganic and organic substances. Toxicity is increased by reduction in water hardness, temperature, dissolved oxygen, chelating agents, humic acids, amino acids, and suspended solids. Adverse effects on growth of some species, such as trout, occur at 0.1 of the 96 hr LC50. Aquatic plants, algae, invertebrates are more resistant than fish. The toxicity in natural waters is less than that predicted from laboratory tests in clean water, probably because of the presence of non-toxic complexes and insoluble precipitates. Sewage effluents containing copper are also less toxic than would be predicted from laboratory data. Only tentative water quality criteria can be formulated because of the lack of field observations indicating concentrations not inimical to fish or fisheries. This is because analytical methods do not distinguish between toxic and nontoxic soluble forms. Nor are there data on fish populations and other poisons frequently present with copper. In the absence of data on the precise effects of copper on natural fish populations, considerable reliance is placed on laboratory data: maximum safe levels should be based on annual 50 and 95 percentile values of 0.05 and 0.2 of the threshold LC50 to rainbow trout; taking into account the effect of water hardness will change the values.

1409 Trace inorganics in rural potable water and their correlation to possible sources. Sandhu, S.S.; Warren, W.J.; Nelson, P. (South Carolina State Coll., Orangeburg). *Water Res.;* **12**: No. 4, 257-261(1978).

Ninety-eight water samples, comprising about 10% of the total sources available to rural homes in Hampton County, South Carolina, were randomly selected and analyzed for inorganic constituents. Chemical contamination is widespread in this area and many people are using substandard quality water. A noticeable number of water samples showed unacceptable levels of arsenic, iron, manganese and mercury. Iron and collodial material were chiefly responsible for turbidity in 19% of the water sources. Acceptable levels of cadmium, chloride, copper, lead, nitrate, phosphate, sodium, total solids and zinc were detected in most of the samples. Statistical analysis indicated that leachings from septic tanks were at least partially responsible for the contamination of shallow water supply sources with nitrate, phosphate, chloride and arsenic. Iron, lead and manganese appear to have come from corrosion of antiquated plumbing in older homes.

1410 Determination of phenylmercury, methylmercury, and inorganic mercury in potable and surface waters. Stary, J.; Havlik, B.; Prasilova, J.; Kratzer, K.; Hanusova, J. (Czech Technical Univ., Prague). *Int. J. Environ. Anal. Chem.;* **5**: No. 2, 89-94(1978).

Extraction chromatography and dithizone extraction were found to be the most promising methods to preconcentrate phenylmercury, methylmercury and inorganic mercury from 100 to 500 ml aqueous samples. By this manner the sensitivity of previously developed radioanalytical methods was increased down to 0.01 ppB. A number of potable and river water samples, beer, wine, fruit juices

etc., have been analyzed for their content of individual mercury species.

1411 Determination of trace metals in marine organisms by atomic absorption spectrometry. Ramelow, G.; Tugrul, S.; Oezkan, M.A.; Tuncel, G.; Saydam, C.; Balkas, T.I. (Middle East Technical Univ., Ankara). *Int. J. Environ. Anal. Chem.;* **5**: No. 2, 125-132(1978).

The application of atomic absorption spectrometry to the analysis of trace metals in marine organisms is described. The samples are digested with nitric acid in teflon decomposition vessels. Mercury is determined by the cold-vapor method while the other elements are determined by flame atomization or flameless graphite-furnace atomization. Several marine species of economic importance are analyzed for seven trace elements.

1412 Preconcentration on silver wool of volatile organo-mercury compounds in natural waters and air and the determination of mercury by flameless atomic absorption spectrometry. Dogan, S.; Haerdi, W. (Univ., Geneva). *Int. J. Environ. Anal. Chem.;* **5**: No. 2, 157-162(1978).

Preconcentration of volatile organo-mercury and metallic mercury on silver microcolumn is particularly suitable for the determination in air and water samples. The microcolumn is coupled to a cell for mercury determination by flameless atomic absorption spectrometry. With this technique, down to 1 ng of mercury can be determined with a good precision (+- 15%).

1413 Microbial degradation of the water-soluble fraction of gas oil. II. Bioassays with pure strains. Kappeler, T.; Wuhrmann, K. (Swiss Federal Inst. of Technology, Zurich). *Water Res.;* **12**: No. 5, 335-342(1978).

The rate of degradation of 47 water-soluble components of gas oil by the mixed autochthonous microflora of clean groundwater as well as by 4 isolates was measured in batch experiments. Identification of some intermediate degradation products gave insight into the primary reactions of the oxidative breakdown of some of the aromatic components of gas oil. Available nitrogen and dissolved oxygen are limiting factors in the microbial purification of hydrocarbon-contaminated groundwater.

1414 Microbial degradation of the water-soluble fraction of gas oil. I. Kappeler, T.; Wuhrmann, K. (Swiss Federal Inst. of Tech., Zurich). *Water Res.;* **12**: No. 5, 327-333(1978).

The microbial degradation of the water-soluble components of gas oil was measured both qualitatively and quantitatively. The mixed autochthonous flora in clean groundwater served as the inoculum in continuous percolation experiments. Concentration gradients of individual compounds as well as of DOC were measured as a function of the percolation time. A lag period of approximately 5 days at 10°C and of approximately 1 day at 25°C respectively preceded measurable attack of the dissolved hydrocarbons. At the experimental infiltration rates, complete hydrocarbon elimination within a few decimeters of percolation depth occurred when steady state conditions of the microbial settlement of the sand were established.

1415 Some theoretical aspects of stability and solubility of inorganic arsenic in the freshwater environment. Wagemann, R. (Freshwater Inst., Winnipeg, Manitoba). *Water Res.;* **12**: No. 3, 139-145(1978).

The concentrations of some major and minor ionic constituents of different freshwater systems are listed, and "typical" concentration estimates are given for freshwater in general. Fourteen different metals are examined for a possible controlling influence on total dissolved arsenic in freshwater. Four metals (Ba, Cr, Fe, Cu) emerge as possible candidates, and are examined more closely. The total dissolved arsenic concentration allowed by each of these metal arsenates is shown as a function of pH when the metal ion activity itself is controlled by a relatively insoluble compound. Barium ion at a concentration typical for freshwater emerges as the most convincing candidate capable of holding total dissolved arsenic to rather low concentrations, while chromium and iron emerge as possibilities. A new E/sub h/-pH diagram for arsenic showing the relative stability domain for barium arsenate is presented in which the arsenic sulfide domains have been included and somewhat simplified and clarified.

1416 Distribution of species of Cu, Pb, Zn, and Cd in a water profile of the Yarra River estuary. Blutstein, H.; Smith, J.D. (Univ. of Melbourne, Parkville, Australia). *Water Res.;* **12**: No. 2, 119-125(1978).

The behavior of Cu, Pb, Zn and Cd in a highly stratified estuary was examined. The distribution of ionic and "organically bound" forms of the metals was determined by differential pulse anodic stripping voltammetry (dpasv) before and after uv irradiation. The two forms of the metals were compared with the water characteristics of salinity, temperature, turbidity, flow, and inorganic and organic carbon. Irradiation increased the concentration of all four elements detectable by dpasv. The greatest increase was for Cu in the 1 m depth river water which yielded 7.5 $\mu g\ l^{-1}$ before irradiation and 29 $\mu g\ l^{-1}$ after irradiation. Cu and Cd showed minimum concentrations in the seawater layer at 4 m depth, corresponding to the fresh seawater flowing upstream below the halocline. The concentrations of Cu and Cd were higher in the river water than in the underlying seawater. Zn concentration in the river water was lower than in the seawater. Relationships between the trace metal concentrations and the characteristics of the water column are not clear, but the direction of water movement is a major influence.

1417 Concentrations of heavy metals in small Norwegian lakes. Henriksen, A.; Wright, R.F. (Norwegian Inst. for Water Research, Oslo). *Water Res.;* **12**: No. 2, 101-112(1978).

As part of regional surveys of lakes in Norway the concentrations of Zn, Pb, Cu and Cd were measured in surface- and bottom-water samples collected from representative, small, pristine lakes (136 in southern Norway sampled in October 1974, 58 resampled in March 1975, and 77 in northern Norway sampled in March 1975). The lakes, a statistically representative sample of small lakes in Norway, were chosen such that their watersheds are undisturbed. Heavy-metal concentrations in these lakes thus reflect only natural inputs and anthropogenic inputs via the atmosphere. The generally low concentrations (Zn 0.5 — 12.0 $\mu g\ l^{-1}$; Pb 0 — 2.0 $\mu g\ l^{-1}$; Cu 0 — 2.0 $\mu g\ l^{-1}$; Cd 0.1 — 0.5 $\mu g\ l^{-1}$) measured in lakes in central and northern Norway provide estimates of natural "background" levels. These estimates may be too high because they include the global-scale deposition of heavy metals from the atmosphere which has increased as a result of industrial activities. Concentrations of Zn and Pb in lakes in southernmost and southeastern Norway lie above these "background" levels, apparently because of atmospheric deposition associated with the acidic precipitation that falls over southern Scandinavia. Increased heavy-metal concentrations in acid lakes may also be due to increased mobilization of metals due to acidification of soil- and surface-waters.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 370, 1346, 1347, 1359, 1373

1418 (COO—2689-9) **Seabed disposal program: geochemical and sedimentological assessment of deep-sea sediments. Progess report for period, 1 January—31 December 1977.** Heath, G.R.; Epstein, G.B.; Leinen, M.; Prince, R.A. (Rhode Island Univ., Kingston (USA). Graduate School of Oceanography). Mar 1978. Contract EY-76-S-02-2689;EY-76-C-04-0789. 165p. Dep. NTIS, PC A08/MF A01.

Sorption experiments involving deep-sea sediments (including MPG clays) and Eu in 0.7M NaCl solutions have shown surprisingly uniform partition coefficients (Kp) of 10,000 to 70,000 for most samples at 15°C. The concentration dependence of Kp is given by: Kp = bC/sup a/, where b depends on sediment type and temperature, C is the final solution concentration, and a, which is a constant for a given cation and sediment, ranges from about -0.6 to -1.0 for Eu. The Eu-sediment experiments yield similar results in both the sorption and desorption directions. The high values of "a" imply that sorption is very strong and approaches irreversibility at very low concentrations. The combined SLA and URI sorption results show that heavy elements, particularly rare earths and actinides, have similar Kp values at 1μM (1000 < Kp < 100,000) and similar a values of < -0.6. Magnetic and geochemical data for MPG-I sediments show consistent core to core depositional patterns like those previously reported for the MPG-II area. The magnetic data support the ichthyolith time scale and suggest that sedimentation has not suffered major interruptions for the past 70 million years. The geochemical data show trends that parallel the sorption results, supporting the hope that we will be able to predict the sorptive behavior of sediments from more easily determined geochemical properties.

1419 Experimental measurements of nitrogen remineralization in coastal waters. Harrison, W.G. (Univ. of California, San Diego). *Limnol. Oceanogr.;* **23**: No. 4, 684-694(Jul 1978).

Ammonium remineralization was measured in the euphotic zone of two coastal areas using a ^{15}N isotope dilution technique. Remineralization fluxes were high in both areas and often exceeded assimilation fluxes. A strong positive correlation between ammonium remineralization and ammonium and carbon dioxide assimilation suggests a close coupling of photosynthesis and nitrogen recycling. Regenerative fluxes decreased with depth and with distance offshore, but to a relatively lesser extent than did assimilative fluxes. Turnover times for remineralization of utilizable organic nitrogen were estimated to be from 3 to 16 days. Size fractionation experiments and estimates from the literature suggest that microplankton (less than 183 μm) may have been the primary nitrogen remineralizers.

1420 Selective uptake of ^{55}Fe from seawater by zooplankton. Jennings, C.D. (Oregon Coll., Monmouth). *Mar. Sci. Commun.;* **4**: No. 1, 49-58(1978).

Iron-55 was measured in water and mixed zooplankton collected in the South Pacific Ocean. The ratios of the specific activity of ^{55}Fe (pCi/g Fe) between plankton and water from the same locations appear to be about 100, which suggests that zooplankton took up ^{55}Fe in preference to stable iron in the South Pacific Ocean.

WATER

REFER ALSO TO CITATION(S) 1342, 1349, 1396

1421 (CONF-780740—1) Predictive capabilities of a two-dimensional model in the ground water transport of radionuclides. Gureghian, A.B.; Beskid, N.J.; Marmer, G.J. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From Management, stabilization, and environmental impact of uranium mill trailings; Albuquerque, NM, USA (24 Jul 1978).

The discharge of low-level radioactive waste into tailings ponds is a potential source of ground water contamination. The estimation of the radiological hazards related to the ground water transport of radionuclides from tailings retention systems depends on reasonably accurate estimates of the movement of both water and solute. A two-dimensional mathematical model having predictive capability for ground water flow and solute transport has been developed. The flow equation has been solved under steady-state conditions and the mass transport equation under transient conditions. The simultaneous solution of both equations is achieved through the finite element technique using isoparametric elements, based on the Galerkin formulation. However, in contrast to the flow equation solution, the weighting functions used in the solution of the mass transport equation have a non-symmetric form. The predictive capability of the model is demonstrated using an idealized case based on analyses of field data obtained from the sites of operating uranium mills. The pH of the solution, which regulates the variation of the distribution coefficient (K/sub d/) in a particular site, appears to be the most important factor in the assessment of the rate of migration of the elements considered herein.

1422 (NUREG/CR—0082) Pollution history of the Savannah River estuary. Final report, September 1, 1976—December 31, 1977. Goldberg, E.D.; Hodge, V.; Griffin, J.J.; Koide, M.; Windom, H. (Scripps Institution of Oceanography, La Jolla, CA (USA). Div. of Geological Research). Apr 1978. 38p. NTIS $4.50.

Records of natural and pollutant fluxes to the Savannah River Estuary are found in some river and marsh deposits into which time frames can be introduced by Pb-210 or plutonium geochronologies. Plutonium releases from the Savannah River Plant are evident in only one deposit and in marsh grass which received the transuranic element from atmospheric transport. The pollution records can be disturbed by bioturbative activities of organisms, by the input of marine solid phases to the estuarine deposits, and by river scour and fill.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 1376, 1419

1423 Fate of ^{14}C-benzene in eggs and larvae of Pacific herring (Clupea harengus pallasi). Eldridge, M.B. (Southwest Fisheries Center, Tiburon, CA); Echeverria, T.; Korn, S. *J. Fish. Res. Board Can.;* **35**: No. 6, 861-865(Jun 1978).

Eggs and larvae of Pacific herring were exposed to low concentrations of ^{14}C-labeled benzene, a soluble, aromatic component of crude oil. All life stages accumulated benzene from water in direct proportion to the initial exposure concentrations, reaching equilibrium within 6 to 12 h. Feeding larvae exposed to benzene through water and live food accumulated benzene initially from the water, then secondarily from the food. The maximum amount of benzene accumulated in tissues was inversely related to age. Eggs accumulated up to 10.9 times the initial concentration, yolk-sac larvae up to 6.9 times, and feeding larvae to 3.9 times. Reasons for these differences in total accumulation and uptake rate are discussed. Results provide evidence for food web magnification of petroleum-based hydrocarbons.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 1361

1424 (SRO—0639-19) Microbial processes and biomass on the Southeastern Continental Shelf. (Georgia Univ., Athens (USA). Inst. of Ecology). Jun 1978. Contract EY-76-S-09-0639. 65p. Dep. NTIS, PC A04/MF A01.

This report presents data collected on four reconnaisance cruises conducted in connection with study of the continental shelf ecosystem. The purpose of the study is to understand the function of the microbial communities of continental shelf waters and the objectives of these cruises were: (1) to obtain preliminary data regarding the spatial distribution and condition of microorganisms in the continental shelf ecosystem of the Southeastern Atlantic bight, and (2) to provide field evaluation of methodologies and instrumentation. Cruises 1 and 2 (June 11 to 17, 1975 and December 1 to 7, 1975) were conducted aboard the R/V EASTWARD and Cruises 3 and 4 (February 8 to 14, 1976 and June 7 to 11, 1976) were conducted aboard the R/V ADVANCE II. Salinity, temperature, and chlorophyll and pheo-pigment concentrations were determined for all stations on all cruises. Adenosine mono-, di-, and tri-phosphate (AMP, ADP, and ATP) concentrations and adenylate energy charge were determined for nearly all stations on all four cruises and are also reported here. Simulated in situ primary production was estimated less frequently. In general, two photosynthesis measurements were conducted each day. Additional pigment samples were taken for HPLC analysis according to the method of Jacobsen 1977. These results differ at times from the usual fluorometric chlorophyll measurement and will be discussed in a later report.

1425 Resource demands for energy development in the Yellowstone River basin. Knapp, J.W. (CH_2M Hill, Sacramento, CA); Leistritz, F.L. *Water Resour. Bull.;* **14**: No. 3, 613-628(Jun 1978).

This paper reports on the development of a mathematical model for forecasting energy development in the Yellowstone study area for the years 1985 and 2000, and determining the associated economic demands for water, land, labor, capital, and mineral resources. The study was prepared for use by the Missouri River Basin Commission in conducting a comprehensive, "Level B" planning study of the water and related land resources in the Yellowstone River Basin. The study results indicate that the amount of coal development in the Yellowstone study area will depend primarily upon state and federal energy policies and regulations. Policies related to slurry pipeline transportation of coal will be particularly important in determining the level and pattern of future energy development in the area. Coal production under the "most probable" scenario is expected to increase from about 40 million tons in 1976 to 163 million tons per year by 1985, and 513 million tons in the year 2000. Consumptive water use for energy development in the study area could be as much as 556,000 acre-feet per year by the year 2000 (under the high scenario). A parametric analysis was conducted on the 1985 most probably scenario to determine the influence on the study results of variations in the delivered price of water. Water requirements were reduced by nearly one-fourth as water costs increased from zero to over $750 per acre-foot.

1426 Technique for predicting in-stream flow requirements of benthic macroinvertebrates. Gore, J.A. (Univ. of Montana, Missoula). *Freshwater Biol.;* **8**: No. 2, 141-151(Apr 1978).

A total of 225 benthic samples was taken at various riffles along the Tongue River in Montana during three separate weekly intervals in 1975. For each sample, depth, current velocity, substrate microprofile, turbulence (Froude number), and the number and kind of species present were considered. The conditions of highest faunal diversity were 75 to 125 cm/s current velocity at 20 to 40 cm depth. The optimum condition appeared to be 76 cm/s at a depth of 28 cm over medium cobble substrates. The centroids for optimum conditions of depth and current velocity for thirty-six common macroinvertebrates are also presented. Representative diagrams of the tolerance ranges of some common invertebrate species are presented. Rhithrogena hageni Eaton was chosen as the indicator species since its tolerances closely matched those of the highest community diversity. The presence of Rhithrogena in future samples would indicate maintenance of adequate flow conditions for the present benthic community. A method for applying these data to produce a minimum flow recommendation is discussed. If the optimum conditions can be plotted on composite hydrologic maps of depth and velocity in riffle areas at various discharges, one can predict the discharge at which the optimum conditions are eliminated and, thus, the recommended minimum discharge.

1427 Metabolic alteration and excretion of anthracene by Daphnia pulex. Herbes, S.E.; Risi, G.F. (Oak Ridge National Lab., TN). *Bull. Environ. Contam. Toxicol.;* **19**: No. 2, 147-155(Feb 1978).

Polycyclic aromatic hydrocarbons (PAH) constitute a series of compounds, some of which are potent carcinogens, which have been detected in natural waters throughout the world. Major sources are aqueous effluents from high-temperature industrial pyrolysis processes, including coke production (Andelman and Suess, 1970). Coal liquefaction, which may provide substantial quantities of synthetic fuel within 15 years, may also release PAH in wastewater streams (Guerin, 1975). Because PAH have been demonstrated to concentrate to high levels in tissues of aquatic organisms (Shimkin et

al., 1951; Scaccini-Cicatelli, 1966; Stegeman and Teal, 1973), a potential exists for biomagnification within food webs to levels hazardous both to fish and to human consumers of aquatic organisms. Corner (1975) has suggested that uptake by filter-feeding organisms may constitute a major mechanism of entrance of PAH to aquatic food chains. In this laboratory, we have demonstrated the ability of several invertebrates to concentrate anthracene, a three-ring PAH compound, from both dissolved and particulate forms. In this paper we present further investigations of the kinetics of excretion and metabolic alteration of anthracene by a representative zooplankter (Daphnia pulex) to evaluate the effect of excretory processes on the potential for bioaccumulation of PAH compounds in aquatic organisms.

1428 Water supply dilemmas of geothermal development in the Imperial Valley of California. Layton, D.W. (Univ. of California, Livermore). *Water Resour. Bull.;* **14**: No. 1, 133-143(Feb 1978).

There are four known geothermal resource areas in the Imperial Valley that have a combined potential of over 4,000 megawatts of electrical energy for 25 years. Water resources available to support geothermal energy development are imported Colorado River water, agricultural waste waters, Salton Sea water, and groundwater. In addition, geothermal power plants can produce their own cooling water from steam condensate. Nevertheless, the relatively high water requirements of geothermal facilities along with a series of real and potential constraints may cause water supply dilemmas involving both the acquisition and use of cooling water. Important constraints are institutional policies, water supply costs, technical problems, and impacts upon the Salton Sea. These constraints and related dilemmas are examined in light of relevant information on the valley's water resources, geothermal resources and energy technologies, cooling water requirements, and water supply options.

REGULATIONS

REFER ALSO TO CITATION(S) 822, 1483

1429 Whose baby are the nasty cargoes. Young, E. *Mar. Pollut. Bull.;* **9**: No. 1, 7-10(Jan 1978).

Many Britains have been advocating that a senior cabinet minister be given responsibility for actively managing Britain's maritime policy. Although Britain is increasingly a coastal region with heavy local interests and responsibilities, her interests as a maritime region are beginning to require the same international Rule of Law that the coastal interests require. Britain may find itself short of sufficient jurisdiction to regulate traffic, which will certainly include bulk chemicals, liquid gases, and nuclear cargoes of various kinds. The author advocates 4 additions to the Composite Negotiating Text: 1. The coastal state must have adequate jurisdiction over all vessels carrying dangerous cargoes travelling through its waters. 2. The flag state must take financial responsibility for dealing with dangerous casualties and "de facto" dumping. 3. Swifter methods for reaching international agreements and putting them into force must be devised. 4. Whenever an international convention or domestic legislation mentions oil pollution, the text should be examined to see if it should not be amended to cover the other "nasty" cargoes as well.

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 23, 126, 268, 818, 856

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 856, 1347

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 272, 273, 274, 1254, 1345

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 124, 1565

1430 Interactions among coexisting predators: a field experiment with dragonfly larvae. Benke, A.C. (Georgia Inst. of Tech., Atlanta). *J. Anim. Ecol.;* **47**: No. 2, 335-350(Jun 1978).

Larval dragonfly populations were manipulated in large littoral zone enclosures to determine the importance of inter-odonate interactions and the effects of dragonflies on their prey. Initial densities of early emerging odonate cohorts were about six times greater in one group of pens than in others. When initial densities were low, survivorship was higher and growth appeared to be faster than when initial densities were high. Highly significant differences of early species densities were maintained between treatment pens during the 6-month experimental period. Early emerging odonates had a highly significant influence on the abundance of the smaller, late emerging odonates, indicating a strong interaction between odonate species. The interaction appeared to be due to predation by large odonates on small odonates. This is interpreted as an extreme form of interference competition which plays an important role in odonate population regulation. Although there was a large treatment bias in prey species abundance, the results indicate that abundance of early emerging odonates plays some role in prey (especially Tanypodinae) abundance. It is suggested that the primary determinant of community structure and production is an interaction between refuge level and predation rate. It is necessary for prey to be turning over at an unusually high rate and it is possible that odonates function in stimulating the rate of prey production.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 1070, 1255, 1485, 1491, 1561

1431 (CONF-780684—1) **Studies with chlorinated dibenzo-p-dioxins, polybrominated biphenyls and polychlorinated biphenyls in a two-stage system of mouse skin tumorigenesis: potent anti-carcinogenic effects.** Berry, D.L.; Slaga, T.J.; DiGiovanni, J.; Juchau, M.R. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 20p. Dep. NTIS, PC A02/MF A01.

From Meeting of the New York Academy of Sciences; New York, NY, USA (22 Jun 1978).

Some topics discussed are as follows; toxic and biochemical effects of dioxins, polybrominated and polychlorinated biphenyls; effects of PCB on carcinogenicity of various chemicals; evaluation of phases of carcinogenesis in mouse skin; inhibitory effects of dioxins on PAH initiation of skin tumors; and induction of monooxygenase enzymes of the skin by dioxins and PCB. (HLW)

1432 (LBL—8105) **Molybdenum—substrate interactions in nitrogenase: an EXAFS study.** Smith, J.P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1978. Contract W-7405-ENG-48. 233p. Dep. NTIS, PC A11/MF A01.

Thesis.

The sensitivity of x-ray absorption edge spectra and extended x-ray absorption fine structure (EXAFS) to the environment of metal atoms make x-ray absorption spectroscopy a useful probe of the environment of the molybdenum in nitrogenase. It is of particular interest to investigate any perturbations of the environment of the molybdenum due to the presence of nitrogenase substrates. The results of measurements of the x-ray absorption spectra of nitrogenase samples by the absorption and fluorescence detection techniques are compared. The procedures used for the growth of Azotobacter vinelandii for the production of nitrogenase and the procedures used for the purification of nitrogenase are described in detail.

1433 Two classes of β pleated-sheet conformation in poly(L-tyrosine): a model for tertiary structure in native proteins. Auer, H.E.; McKnight, R.P. (Univ. of Rochester School of Medicine, NY). *Biochemistry;* **17**: No. 14, 2798-2805(11 Jul 1978).

Poly(L-tyrosine) generates the antiparallel β-sheet conformation at low ionization in aqueous solution. In this work the properties of three samples of (Tyr)/sub n/, numbered 1 to 3 in order of increasing degree of polymerization, were investigated at solute concentrations low enough to form only intramolecular (i.e., nonaggregated) β structures. It was concluded that two classes of β structure are formed by (Tyr)/sub n/ in solution, with samples 1 and 2 comprising class I and sample 3 representing class II. This finding is based on distinctions observed in the sedimentation coefficient and in the far-ultraviolet circular dichroism spectra, ascribed to the side-chain chromophore. Furthermore, distinctions in the entropy change

for the β-disordered chain transition, the breadth of the transition, and the electrostatic potential in the ordered state, based on spectrophotometric-potentiometric titrations on samples 1 and 3, have already been reported. A comparison of the experimental frictional ratios with values calculated from a variety of model ellipsoids of revolution reveals that the hydrodynamic properties of samples 1 and 2 are consistent only with very anisotropic model particles; it is likely that they have only a few polypeptide chain segments folded into long, open-sheet β structures. The properties of sample 3, on the other hand, suggest that it adopts a more compact shape, and it is proposed that the β sheet in this particle is folded over onto itself to generate a double-layered structure. If so this may represent the first instance of prototypical tertiary structure generated in a system as simple as a β-forming homopoly(amino acid). The distinctions observed for all other properties studied are consistent with these proposed hydrodynamic models.

1434 Reaction of ozone with protease inhibitors from bovine pancreas, egg white, and human serum. Leh, F.; Warr, T.A.; Mudd, J.B. (Univ. of California, Riverside). *Environ. Res.;* **16**: No. 1-3, 179-190(Jul 1978).

Ozone inactivates the bovine pancreas trypsin-killikrein inhibitor. Tyrosine and methionine residues are oxidized. When methionine is completely oxidized and 0.5 of the four tyrosine residues is oxidized, 90% of the inhibitor capacity is retained. When both methionine and tyrosine residues are completely oxidized, 37% of the inhibitor capacity is retained. For 50% loss of anti-trypsin activity, 62 moles of O_3/mole of protein were required. Inhibition of the chicken ovomucoid proteinase inhibitor by ozone is accompanied by oxidation of tyrosine, histidine, and methionine residues. For 50% loss of anti-trypsin activity, 32 moles of O_3/mole of protein were required. Anti-trypsin activity of diluted human serum was only slightly inhibited by ozone. Purified α-l-antiprotease from human serum was 50% inactivated by 88 moles of O_3/mole of protein. The oxidation of free tyrosine by ozone proceeds by way of dihydroxyphenylalanine and dihydroxyphenylalanine quinone, finally yielding colored polymeric material.

1435 Reaction of trans-7,8-dihydroxy-anti-9,10-epoxy-7,8,9,10-tetrahydrobenzo(a)pyrene with DNA involves attack at the N^7-position of guanine moieties. Osborne, M.R.; Harvey, R.G.; Brookes, P. (Inst. of Cancer Research, Bucks, Eng.). *Chem.-Biol. Interact.;* **20**: No. 1, 123-130(Jan 1978).

The reaction of trans-7,8-dihydroxy-anti-9,10-epoxy-7,8,9,10-tetrahydrobenzo(a)pyrene (anti-BPDE) with DNA prelabelled with [^{14}C] and [^{3}H]-purine precursors has indicated that in addition to the N^2-position of guanine previously reported reaction also involves the N^7-position of guanine. The hydrocarbon-N^7-guanine product was not detected earlier because it is lost from the DNA very readily at pH 7. The same N^7-product was obtained by reaction of anti-BPDE with guanine in dimethylformamide.

1436 Photosynthetic patterns of Cetraria cucullata (Bell.) Ach. at Anaktuvuk Pass, Alaska. Moser, T.J.; Nash, T.H. III. (Arizona State Univ., Tempe). *Oecologia (Berlin);* **34**: No. 1, 37-43(1978).

The daily photosynthetic patterns of Cetraria cucullata were followed over the 1976 summer period at Anaktuvuk Pass, Alaska. With the exception of rainy periods, the lichen exhibited a strong diurnal pattern with peak photosynthetic activity occurring between 0300 and 0700 h. This correlated with periods of maximal lichen water retention and the presence of direct solar radiation. When the lichen was moist, a strong gradient in photosynthetic activity was observed with no activity in the lichen bases and maximal activity in the lichen tips.

1437 DNA strand scission by benzo[a]pyrene diol epoxides. Gamper, H.B.; Tung, A.S.C.; Straub, K.; Bartholemew, J.C.; Calvin, M. (Univ. of California, Berkeley). *Science;* **197**: No. 4304, 671-673(12 Aug 1977).

Syn- and anti-benzo[a]pyrene diol epoxides elicit a concentration-dependent nicking of superhelical Col El DNA in an in vitro reaction monitored by agarose gel electrophoresis and electron microscopy. This strand scission represents less than 1% of the DNA modification by diol epoxide. Kinetic analysis implicates the formation of unstable phosphotriesters, hydrolysis of which nick the DNA.

1438 Inducible hydrogenase in cyanobacteria enhances N_2 fixation. Tel-Or, E.; Luijk, L.W.; Packer, L. (Univ. of California, Berkeley). *FEBS (Fed. Eur. Biochem. Soc.) Lett.;* **78**: No. 1, 49-52(Jun 1977).

Whether hydrogenase is activated or induced, we found no evidence for activation of either consumption or production of H_2 in aerobically-grown cultures but both of these activities increased 5—20-fold when cultures are grown under H_2 gas. On the other hand, hydrogenase-catalyzed consumption of H_2 is stimulated by light and/or light plus CO_2 in hydrogenase-induced cultures. Nitrogenase activity appears to be induced in cultures grown under H_2. Studies unambiguously establish that in H_2-induced cultures hydrogenase manifests a cooperativity with nitrogenase. In the presence of H_2 the activity of nitrogenase is stimulated 3—5-fold such that rates of about 3 μmol N_2 fixed/mg chlorophyll/h are obtained if the method of Peterson and Burris is used to convert acetylene reduction data to equivalents of $^{15}N_2$ fixation to ammonia.

1439 Immobilization of hydrogenase and ferredoxins on glass beads. Berenson, J.A.; Benemann, J.R. (Univ. of California, San Diego). *FEBS (Fed. Eur. Biochem. Soc.) Lett.;* **76**: No. 1, 105-107(Apr 1977).

It has been shown that Clostridium pasteurianum hydrogenase immobilized on glass beads evolves hydrogen when using dithionite as reducing agent and methyl viologen or ferredoxin as electron carrier. The immobilized enzyme preparations were more resistant to oxygen inactivation than the soluble enzyme. In this study it was found that ferredoxins also may be immobilized on glass beads. The immobilized hydrogenase can utilize soluble ferredoxin reduced by illuminated chloroplasts as an electron donor and immobilized ferredoxin can itself be reduced by illuminated chloroplasts.

1440 K^+ localization in muscle cells by autoradiography, and identification of K^+ adsorbing sites in living muscle cells with uranium binding sites in electron micrographs of fixed cell preparations. Ling, G.N. (Pennsylvania Hospital, Philadelphia). *Physiol. Chem. Phys.;* **9**: No. 4-5, 319-327(1977).

Localization of K^+-adsorption sites on two peripheral regions of the A band and the Z line in frog voluntary muscle cells has been demonstrated with the aid of autoradiography and radioactive ^{134}Cs and ^{204}Tl. The findings confirm the association-induction hypothesis, according to which intracellular K^+ is adsorbed on the beta- and gamma-carboxyl groups of intracellular proteins.

1441 Efficiency of 0.5 N KOH impregnated filters for SO_2-collection. Lewin, E. (Aerosol Sciences Lab., Risoe, Denmark). *Atmos. Environ.;* **11**: No. 9, 861-862(1977).

Cellulose filter papers impregnated with an alkaline solution are used for the collection of SO_2 from ambient air. The influence of linear velocity, SO_2 concentration, loading, temperature and humidity on the collection efficiency of Whatman 41 filters impregnated with 0.5 N KOH is examined. The filters have an efficiency greater than 90 per cent for linear velocities between 50 and 90 cm s^{-1}, SO_2 concentrations up to 0.1 ppm, and r.h. above 30 per cent at temperatures down to -10°C. The efficiency falls strongly for r.h. less than about 30 per cent. The capacity for 10 per cent loading is about 50 μg SO_2 cm^{-2} for filters impregnated according to the procedure described.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 1440

1442 Flame retardation by phosphorus compounds. Granzow, A. (American Cyanamid Co., Bound Brook, NJ). *Acc. Chem. Res.;* **11**: No. 5, 177-183(May 1978).

The author outlines some approaches based upon isotope exchange measurements which reveal detailed steps in enzyme catalyzed reactions. Isotopic exchanges catalyzed by enzymes can be grouped into two main types dependent on whether all the substrates necessary for the occurrence of overall reactions (forward and/or reverse) leading to net chemical change are present. These can be further subdivided; (a) exchange with all substrates present, (b) exchange without substrate present. Other topics include: theory and methodology, detection and characterization of intermediate steps, substrate binding order and relative rates of catalytic steps, substrate synergism, control of catalysis, energy transducing mechanisms. Author believes problem to be solved and not the technique remains paramount. He hopes the account will be of value if it illustrates how better understanding of some problems was gained, and if it aids in the recognition and solution of new problems. 84 references.

CYTOLOGY

REFER ALSO TO CITATION(S) 1437, 1477

1443 (LA-UR—78-1605) Dual-laser flow cytometry of single mammalian cells. Steinkamp, J.A.; Orlicky, D.J.; Crissman, H.A. (Los Alamos Scientific Lab., NM (USA)). [nd]. Contract W-7405-ENG-36. 24p. (CONF-780488—2). Dep. NTIS, PC A02/MF A01.

From 6. conference on automated cytology; Elmau, F.R. Germany (23 Apr 1978).

An improved dual-laser flow cytometric system for quantitative analysis and sorting of mammalian cells has been developed using a low-power argon and high-power krypton laser as illumination sources, thus permitting the excitation of fluorescent dyes

having absorption regions ranging from the ultraviolet to infrared. Cells stained in liquid suspension with fluorescent dyes enter a flow chamber where they intersect two spatially separated laser beams. Separate pairs of quartz beam-shaping optics focus each beam onto the cell stream. Electro-optical sensors measure fluorescence and light scatter from cells that are processed electronically and displayed as frequency distribution histograms. Cells also can be electronically separated and microscopically identified. The ease and versatility of operation designed into this system represent a marked technological improvement for dual-laser excited flow systems. Details of this instrument are described along with illustrative examples of cells stained with mithramycin and rhodamine and analyzed for DNA content, total protein, and nuclear and cytoplasmic diameter.

1444 (LA-UR—78-1658) **Multiangle light-scattering analysis of murine teratocarcinoma cells.** Swartzendruber, D.E.; Price, B.J.; Rall, L.B. (Los Alamos Scientific Lab., NM (USA); Miami Univ., FL (USA)). 1978. Contract W-7405-ENG-36. 25p. (CONF-780488—4). Dep. NTIS, PC A02/MF A01.

From 6. conference on automated cytology; Elmau, F.R. Germany (23 Apr 1978).

Stem cells of the mouse testicular teratocarcinoma are capable of giving rise in vivo and in vitro to a wide variety of cell and tissue types representative of each embryonic germ layer. Multiangle light-scattering measurements in a flow system have been made on these stem cells and on a variety of their differentiated derivatives. This technique is capable of distinguishing the stem cells from parietal yolk sac cells, visceral yolk sac cells, neuronal cells, and squamous cells. However, multipotential stem cells cannot be distinguished from stem cells which are restricted in their development to a single pathway.

1445 (LA-UR—78-1769) **Light scattering with stream-in-air flow systems.** Salzman, G.C.; Wilder, M.E. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 28p. (CONF-780488—5). Dep. NTIS, PC A03/MF A01.

From 6. conference on automated cytology; Elmau, F.R. Germany (23 Apr 1978).

Both forward angle and 90° light-scattering measurements have been used for cell sizing with stream-in-air cell flow systems with very little theoretical base for the measurements. Mie theory calculations are compared with measurements on plastic microspheres. Detector response for homogeneous spheres is shown to be sensitive to refractive index, as well as to particle position within the cell stream.

1446 (LA-UR—78-2001) **Real-time delay monitor for flow-system cell sorters.** Martin, J.C.; McLaughlin, S.R.; Hiebert, R.D. (Los Alamos Scientific Lab., NM (USA)). [nd]. Contract W-7405-ENG-36. 17p. (CONF-780488—1). Dep. NTIS, PC A02/MF A01.

From 6. conference on automated cytology; Elmau, F.R. Germany (23 Apr 1978).

For optimum performance in cell sorting, it is critical to assure proper timing in the charging of droplets to be deflected. A method for determining the transit delay time in cell sorters has been devised and applied to daily operation in the Los Alamos sorter systems. This delay monitor relies on detection of either scattered or absorbed light from cells in the fluid stream near the point of droplet breakoff.

1447 **Stimulation of vitellogenin uptake in Stage IV Xenopus oocytes by treatment with chorionic gonadotropin in vitro.** Wiley, H.S.; Dumont, J.N. (Oak Ridge National Lab., TN). *Biol. Reprod.;* **18**: No. 5, 762-771(Jun 1978).

Ovarian fragments from Xenopus laevis were incubated with various concentrations of human chorionic gonadotropin (hCG) and Stage IV oocytes were subsequently tested for their ability to incorporate vitellogenin. Such oocytes displayed incorporation rates up to 350% greater than controls. This was accompanied by increased endocytotic activity. hCG-stimulated uptake is dose dependent and reaches a maximum at 100 IU/ml, at which concentration ovulation also occurs. At 100 IU/ml of hCG, there is a lag period of at least 12 h between gonadotropin treatment and increased vitellogenin incorporation. Because hCG has little effect on isolated (dissected) cultured Stage IV oocytes which have lost their follicle cells, it is postulated that intact follicle cells are required for the induction of vitellogenin uptake.

1448 **Use of spin labels to evaluate effects of cold shock and osmolality on sperm.** Hammerstedt, R.H.; Keith, A.D.; Snipes, W.; Amann, R.P.; Arruda, D.; Griel, L.C. Jr. (Pennsylvania State Univ., University Park). *Biol. Reprod.;* **18**: No. 4, 686-696(May 1978).

Spin labels were used to evaluate the effects of butylated hydroxytoluene (BHT), rapid cooling to 0°C and osmolality on the integrity of sperm membranes. In vitro incubation of rabbit sperm with 0.5 mM BHT prior to artificial insemination did not alter the fertilizing ability of the sperm. Sperm from 6 species were ranked in terms of susceptibility to membrane damage caused by rapid cooling to 0°C. The integrity of bull and ram sperm membranes was destroyed by the rapid cooling; BHT protected membranes of these spermatozoa from cold-induced lysis. Boar sperm membranes were porous after rapid cooling and BHT did not prevent this membrane damage. Membranes of rabbit and rooster sperm were not damaged by rapid cooling to 0°C. Stallion sperm could not be analyzed because their membranes were altered by addition of reagents necessary to use the technique. The responses of bull, ram and rabbit sperm membranes to hyper- and hypo-osmotic conditions were determined. Hypotonic treatment (less than 200 mOsm) resulted in a 50 percent expansion of the volume of the aqueous compartment of sperm while hypertonic (700 mOsm) conditions compressed the volume of the aqueous compartment to 25 to 30 percent of the volume measured at 300 mOsm. Bull sperm, but not rabbit or ram sperm, responded as "perfect osmometers" between 300 and 700 mOsm.

1449 **Occurrence of diploid ova in Rana pipiens.** Richards, C.M.; Nace, G.W. (Univ. of Michigan, Ann Arbor). *J. Hered.;* **68**: No. 5, 307-312(1977).

All 12 Rana pipiens females tested from three populations produced diploid ova. These were identified by the development of from 0.15 to 35 percent per clutch of normal diploid-like embryos among large numbers of haploid embryos following activation of R. pipiens eggs with irradiated R. clamitans sperm. Their diploid nuclear constitution was demonstrated by diploid cell size at Shumway Stage 19, and by the diploid number of chromosomes both as embryos and as mature frogs, and was confirmed by the occurrence of triploid embryos among normally fertilized progeny from the same female parents. Although the precise cytogenetic events leading to the origin of these diploid ova were not directly determined, we were led to conclude that, although diploid ova may result from polynucleate oocytes, the diploidy reported here was an expression of abnormal meiosis that occurred under genetic control. Such anomalies, at the orders of frequency we observed in R. pipiens, have important consequences for all studies using Anuran model systems.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 1447

GENETICS

REFER ALSO TO CITATION(S) 1449

1450 (CONF-771184—1) **Application of tissue culture technology to southern forestry.** Brown, C.L. (Georgia Univ., Athens (USA). School of Forest Resources). [nd]. Contract EG-77-S-09-1015. 11p. Dep. NTIS, PC A02/MF A01.

From American Pulpwood Association, Southeastern Technical Division meeting; Jacksonville, FL, USA (Nov 1977).

Much progress has been made during the past few years in cloning difficult to propagate conifers and hardwoods. The predicted rate of progress during the next decade will increase several fold because of the increased interest and number of researchers now engaged in tissue culture research in America and in various laboratories around the world. The immediate application to forestry practice will depend on developing operable systems of cloning valuable plus tree selections by the thousands in laboratory flasks followed by transferring these plantlets to preformed tublings containing necessary nutrients and mycorrhizal fungi for rapid development in semi-controlled greenhouses prior to field planting. Laboratory screening for mutants, new hybrid combinations, and haploid lines, will be used more and more in the future to develop improved strains or lines of forest trees. The use of these various techniques accompanied by shorter forest rotations will significantly increase the yields of fiber and cellulose in the South within the next couple of decades.

1451 (ORO—2832-192) **Radiation and biophysical studies on cells and viruses. Progress report 1 July 1977—30 June 1978.** (Anderson (M.D.) Hospital and Tumor Inst., Houston, TX (USA)). [nd]. Contract EY-76-S-05-2832. 81p. Dep. NTIS, PC A05/MF A01.

Studies on genetic structure included arrangement of interphase and mitotic chromosomes, nucleoproteins, and DNA. Studies on analysis of sensitive sites by particle beam irradiation included location of cellular sites for mutation induction and cell transformation. Studies on radiation damage and repair and radiation as an investigative tool included damage to nuclear proteins and other model systems; detection and quantitation of cell surface antigens; interaction of hyperthermia and irradiation; radioinduced cell transformation alkaline elution studies of damage and repair; and low dose, low LET lethality. (HLW)

METABOLISM

REFER ALSO TO CITATION(S) 1383, 1384, 1394, 1427, 1436, 1447, 1491, 1529, 1547, 1548, 1549, 1550, 1556, 1557, 1559

1452 (BNL—24458) **Clinical applicability of the bone mineral content measured by monoenergetic photon absorptiometry.** Cohn, S.H.; Aloia, J.F.; Zanzi, I.; Vartsky, D.; Ellis, K.J. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 17p. (CONF-780642—2). Dep. NTIS, PC A02/MF A01.

From Conference on bone mineral measurement; Toronto, Canada (1 Jun 1978).

Bone mineral content (BMC) measurements were employed in two basic types of studies. In the first type, measurements made on an individual patient are used to trace the time variation in body calcium. In the second type, mineral content of an individual is determined and compared to a standard value. Generally, the standards provided are derived from normal populations grouped by the parameters of age and sex (mean value denoted BMC/sub m/). However, the parameter of skeletal size has generally not been used, on the assumption that the BMC value obtained is a true density measure. The BMC measure is, however, a linear density measure; hence it is essential to use skeletal size as a parameter. The clinical usefulness of relative BMC obtained with the parameters of sex, age and body habitus is evaluated. The normal value (BMC/sub p/) is obtained by an algorithm utilizing values of sex and age, and also height and lean body mass (as derived from ^{40}K measurement). The latter two components characterize skeletal size and body habitus, respectively. For the study, 119 white women were selected from a larger population. Additionally, these women were judged (on the basis of total body neutron activation analysis) to have calcium levels in the normal range. On the basis of physical and roentgenological examination, individuals with evidence of metabolic calcium disorders or osteoporosis were excluded. The variance of BMC values of these individuals, when expressed in terms of BMC/sub p/, was significantly less than when expressed in terms of BMC/sub m/ ($p = 0.95 - 0.99$ as determined by "F" statistic in analysis of variance). Erroneous conclusions on Ca deficit or excess can be drawn for individuals whose height and body size differ markedly from the average, as the variation of their BMC values often exceeds the variation in the mean group.

1453 **Mechanisms contributing to differential sensitivities of plants to SO_2.** Klein, H. (Univ., Giessen, Ger.); Jaeger, H.J.; Domes, W.; Wong, C.H. *Oecologia (Berlin);* **33**: No. 2, 203-208(1978).

SO_2-fumigation experiments were conducted with plants of pea (Pisum sativum) and corn (Zea mays) recognized to be, respectively, sensitive and tolerant to the gas. Accumulation of inorganic sulfur in the tissues revealed that the pea takes up considerably greater amounts of SO_2 than corn. Porometer measurements and transpiration coefficients show that this greater SO_2 uptake is partly related to the lower leaf diffusion resistance of peas. Additional internal sinks for SO_2 uptake are discussed in order to give a complete explanation of the differential SO_2 uptake of the two species.

1454 **Factors affecting respiration and photosynthesis by the benthic community of a subtidal siliceous sediment.** Hartwig, E.O. (Johns Hopkins Univ., Baltimore). Contract AT(11-1)-3279;AT(11-1)-GEN-10. *Mar. Biol.;* **46**: No. 4, 283-293(1978).

In a shallow, subtidal, siliceous sediment, benthic microalgal biomass (μg chlorophyll a cm^{-3}) is influenced by light and physical sediment dynamics. The microalgal community is relatively dense, despite adverse conditions (7.0 μg chlorophyll a c^{-3}), and is able to respond rapidly to favorable conditions. Productivity of this community is significantly correlated ($P <$ or = to 0.05) with benthic light. In addition, productivity is influenced by temperature and bottom water NH_4^+ and PO_4^{-3} concentrations, especially as the concentrations fall to levels approaching the k/sub s/ (half-saturation constant) of the microalgal community. Metabolic activity in this environment is dependent upon a continuous supply of organic carbon. Temperature is significantly correlated with respiration rate, but other factors (e.g., biomass and organic matter supply) are important also. Community respiration responds to overlying phytoplankton productivity in the same manner as deep-water benthic environments. Bacterial enumeration using CFU (colony-forming units) does not measure accurately the number of in situ metabolically active bacteria.

1455 **Inhibitory effect of nitrate on reduction of N_2O to N_2 by soil microorganisms.** Blackmer, A.M.; Bremner, J.M. (Iowa State Univ., Ames). *Soil Biol. Biochem.;* **10**: No. 3, 187-191(1978).

The ability of soils to reduce N_2O to N_2 depends very largely on their NO_3^- content. Low concentrations of NO_3^- delay reduction of N_2O to N_2 by soil microorganisms, and high concentrations of NO_3^- almost completely inhibit this process. The inhibitory effect of NO_3^- on N_2O reduction increases markedly with decrease in soil pH. These observations account for the finding in previous work that accumulation of N_2O during denitrification of NO_3^- in soils incubated in closed systems is favored by high NO_3^- concentration and by low pH. They also indicate that, even if increased N fertilization of soils does not lead to a significant increase in the amount of N volatilized from soils as N_2 and N_2O through denitrification of NO_3^-, it may cause a substantial increase in the ratio of N_2O to N_2 and thereby pose a threat to the stratospheric ozone layer.

1456 **Passage of metals to freshwater fish from their food.** Patrick, F.M.; Loutit, M.W. (Otago Univ., Dunedin, New Zealand). *Water Res.;* **12**: No. 6, 395-398(1978).

Following work showing that Cr, Cu, Mn, Fe, Pb and Zn could be concentrated by tubificid worms after ingesting metal-enriched heterotrophic bacteria, experiments were carried out in which fish, fed these worms, showed increased metal levels in their tissues after four days. Only Pb was found in increased concentrations after a shorter period of two days. Both young and older fish were used in the experiments, and the results indicate that increased levels of most metals in the fish reflect the concentrations of the metals in their food if the fish are exposed to the food for longer than two to four days, and that the age of the fish has an effect on their final metal concentrations.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 1447, 1535

1457 **Excretion rate of ^{65}Zn: is it a useful tool for estimating metabolism of fish in the field.** Hoss, D.E.; Peters, D.S.; Hettler, W.F.; Clements, L.C. (National Marine Fisheries Service, Beaufort, NC). *J. Exp. Mar. Biol. Ecol.;* **31**: No. 3, 241-252(Mar 1978).

Several experiments were conducted with pinfish, Lagodon rhomboides (L), and black sea bass, Centropristis striata (L.), to determine the practicality of using the rate of loss of ^{65}Zn to estimate the metabolic rate of fish under natural conditions. No significant correlations were found between this and oxygen consumption, feeding rate, fish size, or temperature. Restricting fish movement had no consistent effect on zinc loss nor did elevated levels of inorganic zinc in the diet. Because of the lack of positive results, we concluded that the rate of loss of ^{65}Zn is not a practical method for estimating field metabolism of fish.

1458 **Relationship of molecular structure to in vivo scintigraphic distribution of carbon-11-labeled compounds. IV. Carbon-11-labeled mandelonitriles, Mandelic acids, and their esters.** Winstead, M.B.; Dougherty, D.A.; Lin, T.H.; Khentigan, A.; Lamb, J.F.; Winchell, H.S. (Bucknell Univ., Lewisburg, PA). *J. Med. Chem.;* **21**: No. 2, 215-217(Feb 1978).

^{11}C-Labeled HCN was collected in water containing carrier KCN following bombardment of 99% N_2-1% H_2 with 22 MeV protons. ^{11}C-Labeled mandelonitrile and p-methoxy-, p-hydroxy-, and 3,4-dihydroxymandelonitrile were synthesized from $K^{11}CN$ and the corresponding benzaldehyde. The initial distribution of ^{11}C activity of these nitriles in dogs was primarily in the region of the heart, liver, and kidneys followed by rapid redistribution to the parotids and stomach with [^{11}C]hydroxymandelonitriles. ^{11}C-Labeled mandelic acid and m-methyl-, o-chloro-, and p-chloromandelic acid were synthesized from the corresponding [^{11}C]mandelonitrile. Serial scintigraphy of ^{11}C activity of these mandelic acids in dogs showed progressive renal excretion with accumulation of activity in the bladder. ^{11}C-Labeled ethyl and benzyl mandelate were synthesized from [^{11}CA]mandelic acid. These esters showed initial accumulation of activity in the lungs with eventual excretion by the kidneys.

MEDICINE

REFER ALSO TO CITATION(S) 1138, 1505, 1561

1459 **Ultrasonic technique for characterizing skin burns.** Goans, R.E.; Cantrell, J.H. Jr. Meyers, F.B.; Stambaugh, H.D. (to Dept. of Energy). US Patent 4,080,960. 28 Mar 1978. Filed date 4 Nov 1976. 8p.

PAT-APPL-738,982.

This invention, a method for ultrasonically determining the depth of a skin burn, is based on the finding that the acoustical impedance of burned tissue differs sufficiently from that of live tissue to permit ultrasonic detection of the interface between the burn and the underlying unburned tissue. The method is simple, rapid, and accurate. As compared with conventional practice, it provides the important advantage of permitting much earlier determination of whether a burn is of the first, second, or third degree. In the case of severe burns, the usual two - to three-week delay before surgery may be reduced to about 3 days or less.

1460 Induction of antibodies against carcinogenic polycyclic aromatic hydrocarbons. Moolten, F.L. (Boston Univ., MA); Capparell, N.J.; Boger, E.; Mahathalang, P. *Nature (London);* **272**: No. 5654, 614-616(1978).

Data from studies with mice and guinea pigs suggest that an analogue of the polycyclic aromatic hydrocarbon (PAH) carcinogen dimethylbenzanthracene (DMBA), substituted with a fluorine moiety to abrogate carcinogenicity, can induce antibodies which bind a variety of PAH carcinogens; that these antibodies can protect tissue culture cells against one of the prominent in vitro biological effects of such carcinogens--toxicity; and that gastrointestinal mucosal immunization against PAH carcinogens is feasible, and possibly represents a means of achieving in vivo protection by enhancing carcinogen excretion.

1461 Effects of intravenous vasopressin on canine mesenteric arterial blood flow, bowel oxygen consumption, and cardiac output. Athanasoulis, C.A.; Waltman, A.C.; Simmons, J.T.; Sheehan, B.; Coggins, C.H. (Massachusetts General Hospital, Boston). *Am. J. Roentgenol.;* **130**: No. 6, 1033-1039(1978).

The effects of various doses of intravenous vasopressin on mesenteric arterial blood flow, intestinal oxygen consumption, and cardiac output in anesthetized dogs were investigated. Optimal dose rate of intravenous vasopressin was found to be 3.0 mU/kg/min. At this dose rate, mesenteric arterial blood flow, intestinal oxygen consumption, and cardiac output decreased by 57%, 57% and 26%, respectively. Increasing the dose rate to 8.0 mU/kg/min did not offer significant gains. Maximum effect was observed 20 min after the beginning of the infusion. The effects disappeared 10 to 20 min after the infusion was discontinued, with the exception of superior mesenteric blood flow which showed a rebound increase. We conclude that in the anesthetized dog, intravenous infusions of vasopressin at low dose rates (3.0 mU/kg/min) substantially reduce mesenteric blood flow and intestinal oxygen extraction with moderate reduction of cardiac output. Possible clinical applications of low dose intravenous infusions of vasopressin would include reduction of portal hypertension and bowel protection during radiation therapy.

1462 Axial transverse tomography system. Bossaert, J. (to Thomson-CSF). US Patent 4,021,673. 3 May 1977. Priority date 18 Mar 1975, France. 8p.

Axial transverse tomography system analyzing a transverse section of a body by means of a source of X-rays and a detector of X-rays located on opposite sides of the section and in motion about the section. The data received by the detector are employed simultaneously with their formation for an optical reconstitution of the picture from the densities of absorption of the analyzed section. A filter having a predetermined spatial transparency law, associated with the reconstitution optical system, enables a good picture to be obtained.

1463 Neuropathology of tissues from patients treated by the Brain Tumor Study Group. Mahaley, M.S. Jr.; Vogel, F.S.; Burger, P.; Ghatak, N.R. (Univ. of North Carolina, Chapel Hill). *Natl. Cancer Inst. Monogr.;* **46**: 77-82(1977).

The histopathologic diagnoses in 718 brain tumor patients entered in the Brain Tumor Study Group were reviewed, as well as those for 53 of these patients who were autopsied later. This review documented instances of progression of histologic anaplasia. Of particular interest in the autopsied cases were several instances of extensive necrosis in white matter distant from persisting glioma following chemotherapy and radiotherapy. This observation suggested the presence of a structural and/or metabolic alteration in the diseased hemisphere that perhaps makes it more susceptible to further alterations secondary to the adjunctive therapy.

1464 Hyperbaric oxygen and radiation therapy in the management of glioblastoma. Chang, C.H. (Columbia Univ., New York). *Natl. Cancer Inst. Monogr.;* **46**: 163-169(1977).

A pilot clinical trial on radiotherapy of glioblastoma with and without hyperbaric oxygen was performed at the Columbia-Presbyterian Medical Center. Eighty previously untreated patients with histologically proved glioblastoma were evaluated; 38 were irradiated under hyperbaric oxygen and 42 (controls) in atmospheric air. The survival rates were calculated according to the actuarial analysis method. At the end of 18 months, the survival rate appeared considerably higher in the oxygen group (28 percent) than in the controls (10 percent). At the end of 36 months, no patients in the control group survived, whereas 2 patients in the oxygen group were alive beyond 45 and 48 months, respectively. The median survival time was 38 weeks for those treated under oxygen and 31 weeks for the air control group. Owing to the small population samples and the pilot nature of this study, the difference in survival rates between the two groups was not statistically significant. The toxicity of hyperbaric oxygen was well tolerated by most patients, and the quality of survival in the hyperbaric oxygen group was equal to or slightly better than that of the control group. This pilot clinical study paved the way for further controlled clinical trials of hyperbaric oxygen and oxygen-mimicking drugs, including the electron-affinic compounds that could have differentially sensitized the hypoxic tumor cells.

1465 Method of protecting human skin from actinic radiation. Fusaro, R.M. (to Regents of the Univ. of Minnesota). US Patent 3,920,808. 18 Nov 1975. Filed date 8 May 1973. 8p.

Enhanced protection from sunlight is achieved by applying to human skin beforehand separate, time-spaced applications of (1) a carbonyl compound which is reactive with amino groups in human skin, for example dihydroxyacetone, and (2) a benzo- or napthoquinone such as lawsone. Preferably several sequential applications of each active component in a separate carrier are made the evening before the first exposure, and protection is thereafter maintained by applying each component separately each evening.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 1461, 1463, 1464

1466 (COO—4115-24) **Harvard—MIT research program in short-lived radiopharmaceuticals. Progress report, September 1, 1977—April 30, 1978.** Adelstein, S.J.; Brownell, G.L. (Massachusetts Inst. of Tech., Cambridge (USA); Harvard Medical School, Boston, MA (USA)). May 1978. Contract EY-76-S-02-4115. 112p. Dep. NTIS, MF A01.

Portions of document are illegible.

Progress is reported on the following studies: chemistry studies designed to achieve a more compiete understanding of the fundamental chemistry of technetium in order to facilitate the design of future radiopharmaceuticals incorporating the radionuclide /sup 99m/Tc; the development of new radiopharmaceuticals intended to improve image quality and lower radiation doses by the use of short-lived radionuclides and disease-specific agents; the development of short-lived positron-emitting radionuclides which offer advantages in transverse section imaging of regional physiological processes; and studies of the toxic effects of particulate radiation.

1467 (COO—4533-1) **Efficacy of clinical diagnostic procedures utilized in nuclear medicine. Nine month progress report.** (Cincinnati General Hospital, OH (USA)). 1978. Contract EE-77-S-02-4533. 21p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

This study is designed to determine the efficacy of nuclear medicine procedures in clinical practice. Several methods of determining efficacy will be evaluated to determine those most suitable. Nuclear medicine methods will be confined to the study of lung diseases by pulmonary perfusion and ventilation. In addition to evaluating the above methods data will be obtained to determine the sensitivity, specificity, predictive value and efficiency of the test under consideration. These values, corrected for prevalence of the disease processes under consideration will then be compared to the values obtained by the MACRO and MICRO methods and will help to bound the clinical reliability of the diagnostic method depending on the degree to which the several methods trend together. Depending on the practicality of these two methods, in addition to the determination of efficacy, cost effectiveness factors and benefit-risk estimates which are used to apply to radiation effects will be determined for nuclear medicine studies of the brain, bone, heart, liver and thyroid subsequently. The measurement techniques will then be utilized to establish guidelines for the most useful applications of the given procedure so that clinicians will be able to obtain a pretest estimate of the utility of the nuclear medicine test.

1468 (ORO—2401-108) **Radioisotope studies utilizing a low level whole body counter and clinical applications of activation analysis. Progress report.** Brill, A.B. (Vanderbilt Univ., Nashville, TN (USA). Medical Center). 31 Jul 1978. Contract EY-76-S-05-2401. 89p. Dep. NTIS, PC A05/MF A01.

Studies on dosimetry included: comparative dosimetry of iodocholesterol compounds; ^{59}Fe and ^{111}In dosimetry in abnormal human subjects; dosimetry of intraperitoneally administered ^{32}P colloid; evaluation of the standard man model for dosimetry calculations; radiosensitivity of the thyroid during ^{131}I therapy; environmental monitoring of nuclear power reactors; distribution and excretion of lung imaging agents; and organ distribution and excretion of /sup 99m/Tc—Sn—Methylene diphosphonate. Supporting systems development studies were conducted on hardware and software. Hardware studies included microprocessor controlled quantitative scanner and digital computer interface for a longitudinal tomographic scanner for human dosimetry studies. Software studies included acquisition, reconstruction, and display of tomographic data, simulation and modeling, and computer programs in nuclear medicine. (HLW)

1469 Improved method for noninvasive measurement of regional cerebral blood flow by ^{133}Xe inhalation. I. description of method and normal values obtained in healthy volunteers. Meyer, J.S.; Ishihara,

N.; Deshmukh, V.D.; Naritomi, H.; Sakai, F.; Hsu, M.C.; Pollack, P. (Vetrans Administration Hospital, Houston, TX). *Stroke;* 9: No. 3, 195-205(1978).

A clinical method for noninvasive measurement of regional cerebral blood flow (rCBF) and blood volume (rCBV) is described, based on Obrist's 10 minute, desaturation method after 1 minute inhalation of ^{133}Xe. Sixteen collimated probes are placed over both hemispheres and brain stem-cerebellar regions. End-tidal ^{133}Xe curves are used for correction of recirculation. KEV discriminators are set to record gamma and x-ray activity separately. Values are printed out automatically by a computer on a brain map. Extracerebral contamination is reduced by (1) computing curves from gamma activity, (2) applying pressure on the scalp beneath the probes, (3) 1 minute inhalation of ^{133}Xe and recording desaturation curves for 10 minutes, thereby minimizing slow clearance from extracranial tissues. Normal values for both fast and slow compartments are reproducible and are in good agreement with the carotid injection method. The speech dominant hemisphere has higher flow than the right under conditions described. Posterior portions of the cranium over the cerebellum and brain stem appear to have higher flow gray values than the cerebral cortex. Gray matter flow decreases with advancing age.

1470 Localization of Hodgkin's disease and lymphomas by 67-gallium substraction scanning. Krolikiewicz, H.; Maruyama, Y.; Deland, F.H.; Beihn, R.M.; Hafner, T.; Utley, J.F. (Univ. of Kentucky, Lexington). *Oncology;* **34**: No. 4, 179-184(1977).

^{67}Ga-subtraction scan was found to be useful and a promising new method for the pre-treatment evaluation of the patient with Hodgkin's disease or non-Hodgkin's lymphoma. The scan appeared to be most accurate in the neck, chest, and axillary regions. It appears to offer a means of increasing the accuracy of evaluating the abdomen, the para-aortic and pelvic regions. It may be a useful method for the follow-up to detect recurrences. It was an easily performed, safe, non-invasive test, well tolerated and accepted by patients.

1471 Isotope release cytotoxicity assay applicable to human tumors: the use of 111-indium. Frost, P.; Wiltrout, R.; Maciorowski, Z.; Rose, N.R. (Wayne State Univ., Detroit). *Oncology;* **34**: No. 3, 102-104(1977).

We have demonstrated that human tumors can be labelled efficiently with the 111indium-oxine chelate. Subsequently, this isotope can be released by cytotoxic lymphoid cells. Both natural and induced cytotoxicity can be demonstrated utilizing this isotope release method. Because of the slow spontaneous release of 111indium and its efficient labelling of human tumor cells, this isotope release assay can be utilized in long-term cytotoxic assays in the study of human tumor immunology.

1472 Long-term prognosis for cerebral infarction in relation to brain circulation: a 7-year follow up study. Fujishima, M.; Nishimaru, K.; Omae, T. (Khushu Univ., Fukuoka). *Stroke;* **8**: No. 6, 680-683(1977).

Seventy-seven patients with cerebral infarction have been re-examined every year and followed for 7 years. Thirty-one patients had normal cranial blood flow (BF) and the remaining 46 had subnormal cranial BF, determined by the intravenous RISA method at the time of the original attack. During a 7-year follow up, 7 patients (22.6%) of the normal cranial BF group died; 3 of stroke and the remaining 4 from other causes, while 24 patients (52.2%) of the subnormal cranial BF group died; 13 of stroke and the remaining 11 of various diseases. The cumulative survival rate was consistently lower in the subnormal cranial BF group than the normal one. This difference reached statistical significance at 5 and 7 years of follow up. However, stroke recurrence did not differ significantly between the 2 groups. This suggests that a decreased cranial BF is an indicator of a poor long-term prognosis.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 269, 1385, 1392, 1393, 1413, 1414

1473 Utilization of the gas condensate produced at the Fergana Petroleum Refinery Plant by Candida and Torulopsis yeasts. Bil'mes, B.I.; Borodina, R.A.; Galkina, N.N.; Kasymova, G.A.; Runov, V.I. (Inst. of Microbiology, Uzbek SSR). *Uzb. Biol. Zh.;* No. 2, 3-5(1978). (In Russian).

Dearomatized gas condensate from the Fergana Refinery Plant was employed as sole carbon source for Candida lipolytica, C. curvata, and Torulopsis candida cultured in 10 L and 100 L fermenters on a mineral medium at 28 to 30°C with aeration. Under these conditions the mean biomass yield was 6.1 g/L, consisting of 52 to 60% crude protein (Nx6.25), 37.8 to 40.6% protein (Lowry), 5.1 to 21.5% lipids, and 4.1 to 12.1% residual hydrocarbons. Hot extraction of the biomass with 1:1 alcohol:ether reduced the lipid content to 1.01 to 5.5%, and cold extraction with hexane reduced residual hydrocarbons to 0.2%.

1474 Effect of nutrient medium composition on the biosynthesis of cellulolytic enzymes with submerged cultivation of fungus Trichoderma longibrachiatum. Salovarova, V.P.; Grachev, Yu.P.; Vaganova, M.S. (Moscow Technological Inst. of Food Industry). *Prikl. Biokhim. Mikrobiol.;* **14**: No. 2, 172-176(1978). (In Russian).

An optimal medium for biosynthesis of cellulolytic enzymen using submerged cultivation of Trichoderma longibrachiatum 7-26 was sought. The culture was in a rocker (200 rot/min) in 750 ml flasks at 28 to 30°. Components of the medium to promote biosynthesis of cellulolytic enzymes were examined. Among carbon sources, sugarbeet pulp (2%) was associated with the greatest amount of cellulolytic enzyme production. Maximum results with sources of mineral nitrogen were seen with addition of nitric acid ammonia (C_1 enzyme activity, based on paper disintegration, was 5.44 units/ml). Further addition of KH_2PO_4 raised enzyme activity. Examination of some organic substances indicated that malt sprouts and corn extract improved the medium. Optimization of the program was calculated based on the Box-Williams method. An ideal medium was proposed: sugarbeet pulp-4.60%, ammonium nitrate-0.70%, KH_2PO_4-0.30%, and malt sprouts and wheat clippings in a ratio 1 : 0.750. This medium produced an activity of 16.3 units/ml for C_1 enzyme and 193.8 units/ml for C/sub x/ enzyme activity (based on amount of sugars formed under action of the enzyme in 1% solution of sodium carboxymethyl-cellulose).

1475 Method and apparatus for detecting micro-organisms. Mirsky, J. US Patent 3,941,660. 2 Mar 1976. Filed date 20 Jan 1975. 8p.

A method and apparatus is described for determining the presence and quantity of microorganisms, such as bacteria, fungi and yeast, in a given sample. The apparatus includes two sealed containers, a portion of which may be penetrated by a sharp instrument, as for example, glass vials with flexible septum tops. One container includes a radioactive nutrient medium which is capable of supporting the life process of the microorganism whose presence is being tested. The second container includes a liquid scintillation solution which absorbs the product of metabolism of the organisms. The sample is introduced into the first sealed container, for example, by means of a standard syringe. Any microorganisms present will consume the radioactive nutrient and as a result produce radioactive waste. Means are then applied to penetrate the containers and allow the flow of the radioactive metabolic product from the first container to the second container while preventing any contamination from the ambient. The liquid scintillation solution will emit light in proportion to the amount of the product of metabolism collected from the first container. This light may be detected by standard liquid scintillation counters, thus providing a qualitative and quantitative measure of the microorganism in the tested sample.

1476 Ecological studies on algae isolated from the effluents of an oil refinery, a fertilizer factory and a brewery. Kumar, H.D. (Banarus Hindu Univ.); Bisaria, G.P.; Bhandari, L.M.; Rana, B.C.; Sharma, V. *Indian J. Environ. Health;* **16**: No. 3, 247-255(Jul 1974).

Tha algal flora and physico-chemical characteristics of the effluents of the Indian Oil Refinery, Barauni; the Sindri Fertilizer Factory, Sindri; and the Mohan Meakin Brewery, Ghaziabad were studied. The studies indicate that algae can tolerate and grow in highly polluted waters. The blue-green algae, flagellates and euglenoids are mostly associated with organically rich effluents, low in dissolved oxygen, whereas waters rich in nitrogenous compounds favor the growth of green algae, e.g., Chlorella. A combination of algal and chemical characteristics may be successfully employed to evaluate the water quality of a given habitat.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 1475

MORPHOLOGY

1477 (CONF-780672—1) **Follicular growth and atresia in the mouse.** Oakberg, E.F. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

From Tissue culture meeting; Denver, CO, USA (5 Jun 1978).

Follicles were classified on the basis of number of layers of follicle cells, presence and degree of development of the zona pellucida, and presence of an antrum. Formation of an antrum in follicles with less than 7-8 cell layers and/or presence of necrotic cells was considered indicative of degeneration. When classified in this manner, the data suggest that follicles and their contained oocytes are committed to either normal development or atresia by the time a third layer of granulosa cells is formed.

PATHOLOGY

REFER ALSO TO CITATION(S) 177

1478 Plaque, caries, periodontal diseases, and acculturation among Yanomamoe Indians, Venezuela. Donnelly, C.J. (Univ. of Michigan, Ann Arbor); Thomson, L.A.; Stiles, H.M.; Brewer, C.; Neel, J.V.; Brunelle, J.A. *Community Dent. Oral Epidemiol.;* **5**: 30-39(1977).

The number of DM and d teeth and surfaces was recorded for 220 Yanomamoe Indians from three groups of villages with different degrees of contact with Western culture. Specimens of plaque were taken from the teeth, transported in a holding solution, cultured, and examined for specific oral streptococci. In addition, the periodontal health and oral hygiene of one group of villagers were assessed using the Russell PI and the Greene and Vermillion OHIS. Caries experience among the Yanomamoe was shown to be positively associated with exposure to Western culture. S. mutans was recovered with about the same frequency from specimens taken from the teeth of Indians living at all three village locations. However, the presence of S. mutans alone did not account for the disparity in dental caries scores. The examinees had abundant and persistent accumulations of soft deposits on their teeth accompanied by markedly inflamed gingival tissues. However, periodontal pockets and loss of appreciable amounts of bone did not appear as early in life nor were they as severe as reported for some other populations which practice little oral hygiene. Those disparities in the distribution of plaque-induced oral diseases between Western populations and the Yanomamoe warrant further study.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 1512, 1544

1479 Force measurement using an inductively coupled sensor. Ashworth, H.A.; Milch, J.R. (Department of Physics, Princeton University, Princeton, New Jersey 08540). *Rev. Sci. Instrum.;* **49**: No. 11, 1600-1601(Nov 1978).

A low-compliance, high-bandwidth force sensor is described. The bending of a quartz plate is converted to an analog voltage by using a phase-locked loop to measure the change in frequency of two oscillators inductively coupled to the plate. The resolution of the sensor is approximately 10^{-5} N, with a bandwidth of approximately 1 kHz.

1480 Fatty acid dynamics in Thalassiosira pseudonana (Bacillariophyceae): implications for physiological ecology. Fisher, N.S.; Schwarzenbach, R.P. (Woods Hole Oceanographic Institution, MA). *J. Phycol.;* **14**: No. 2, 143-150(Jun 1978).

The growth, dry weight, fatty acid weight and fatty acid composition of two clones of Thalassiosira pseudonana Hasle and Heimdal were measured under several growth conditions. Determinations of total cellular fatty acids were made using chemical ionization mass spectrometry. Both clones had the same fatty acids, dominated by C14:0, C16:0, C16:1, C16:3, C16:4, C18:4 and C20:5, though in different relative amounts. Fatty acids typically represented 5—10 percent the dry weight of a cell during log phase growth and up to 22 percent during stationary phase. The C16 fatty acids of both clones changed as the cultures aged, though much more markedly in the Sargasso Sea clone (13-1) than in the estuarine one (3H). The C16:0 and C16:1 acids of both clones declined sharply in the dark and were replenished in the light. Cells maintained in constant illumination, but with no cell division, produced large quantities of these acids. Cells of clone 13-1 treated with polychlorinated biphenyl (PCB) initially grew more slowly than control cells, weighed more, and had higher relative amounts of C16:0 and C16:1. Fatty acid studies may provide useful indicators of ecologically important energy reserves and membrane adaptations in the algae.

1481 Transplantation of allogeneic bone marrow without graft-versus-host disease using total lymphoid irradiation. Slavin, S.; Fuks, Z.; Kaplan, H.S.; Strober, S. (Stanford Univ., CA). *J. Exp. Med.;* **147**: No. 4, 963-972(1978).

Bone marrow (BM) and skin allografts from C57BL/Ka (H-2b/b) mice were transplanted to BALB/c (H-2d/d) recipients treated with total lymphoid irradiation (TLI), whole-body irradiation (WBI), or fractionated thymic irradiation TLI prolonged skin allograft survival about five times as long as that in untreated controls, and allowed for permanent engraftment of BM cells in approximately equal to 90% of recipients. None of the BM recipients showed clinical signs of graft-versus-host disease (GVHD) (diarrhea, weight loss, hunched back, etc.). On the other hand, recipients given WBI and allogeneic BM cells developed severe clinical GVHD. The majority of the latter recipients died within 12 days after BM transplantation, and 95% died within 61 days. Although TLI protected BALB/c mice against GVHD induced by BM cells, all recipients given TLI and allogeneic spleen cells developed lethal GVHD. Thymic irradiation alone marginally prolonged skin allograft survival, and did not allow for allogeneic BM engraftment. These results suggest that TLI may be a useful regimen in clinical BM transplantation, since this form of radiotherapy is used extensively in humans and has few severe side effects.

1482 Quantitative method for the separation of chlorophylls a and b from phytoplankton pigments by high pressure liquid chromatography. Jacobsen, T.R. (Univ. of Georgia, Athens). *Mar. Sci. Commun.;* **4**: No. 1, 33-47(1978).

A rapid quantitative high pressure liquid chromatographic (HPLC) method is described for the determination of nanogram amounts of chlorophyll a and b. Comparison of the HPLC method with classical spectrophotometric and fluorometric methods has shown the inaccuracy of the latter methods in separating chlorophyll a from the pigment matrix found in biological samples. The HPLC method offers increased sensitivity, compatibility with shipboard analysis, and reduced analysis time over presently used TLC methods for determination of chlorophyll a.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 1546

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 1548

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 828, 1379, 1573

1483 (CONF-770966—1) **Mirex: a risk benefit evaluation.** Waters, E.M.; Gerstner, H.B.; Huff, J.E. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 30p. Dep. NTIS, PC A03/MF A01.

From Solar industrial process heat symposium; College Park, MD, USA (19 Sep 1977).

In early 1974, the EPA expressed the following concerns over the widespread use of mirex: (1) adverse effects on reproduction as demonstrated in laboratory animals; (2) detectable amounts found in human adipose tissue from a limited sampling of the population; (3) tumorigenic implications in mice; (4) effects on mammalian energy metabolism; (5) effects on mortality in birds; (6) potential to move in a saltwater environment; (7) effects on certain aquatic organisms; and (8) persistence in the environment. The tortuously long legal battle over mirex appears to be entering its final chapter. Agreement has been reached by the EPA and the state of Mississippi to phase out all current mirex registrations. Cancellation for mirex 10:5 bait (a recently developed dilute form of mirex) should become effective at the end of 1977. Selective ground application would be permitted only until June 1978. But the fire ant problem remains unsolved. Crop losses due to fire ant infestations are reported to run to hundreds of millions of dollars annually, to say nothing of the loss of parkland and other recreational facilities. Recent research has been directed towards finding a mirex substitute: among those proposed are chlorpyrifos, diazinon, dimethoate, and methyl bromide. Another research effort is attempting to modify mirex by combining it with amines, therefore making it more polar and more water soluble. This compound should degrade within a matter of days and thereby remove the problem of residue accumulation. The use of pheromones and hormones to disrupt the life cycle of the fire ant is also being investigated. Growing public concern and pressure from environmentalists are among the factors which have contributed to the usage restrictions and proposed cancellation of mirex. Advocates of mirex question these use restrictions and proposed cancellation, claiming that the fire ant poses greater threats to humans and livestock than does the pesticide.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 1158

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

1484 (BNL—24539) **Special type of UV-stimulated recombination in Haemophilus influenzae.** Waldstein, E.; Setlow, J.K.; Santasier, L. (Brookhaven National Lab., Upton, NY (USA)). [nd]. Contract EY-76-C-02-0016. 18p. (CONF-780694—1). Dep. NTIS, PC A02/MF A01.

From Symposium of quantitative biology; Cold Spring Harbor, NY, USA (1 Jun 1978).

Following uv irradiation, the DNA of wild type H. influenzae undergoes extensive exchange between strands synthesized before and after irradiation. There are apparently many more exchanges than uv-induced pyrimidine dimers, unlike the situation in Esherichia coli. Such uv-induced exchange does not take place in the highly recombination-defective rec1 strain of H. influenzae, but is extensive in the even more recombination-defective rec2 strain. These events are correlated with the filling of the single-strand gaps made in DNA synthesized after uv; in rec2 the gaps are filled normally, but there is little or no gapfilling in rec1. Normal DNA replication is not required for gapfilling, since it takes place in a temperature-sensitive DNA synthesis mutant at a temperature restrictive for DNA synthesis. Thus it is probable that in H. influenzae exchange is more important for gapfilling than is de novo synthesis. In order to find out more about uv-induced exchange, we have examined the question of whether dimers originally in DNA synthesized before irradiation could be shifted into the DNA made after irradiation by way of such a mechanism.

1485 (COO—2814-3) **Molecular basis for the mutagenic and lethal effects of ultraviolet irradiation. Progress report, December 1, 1977—November 30, 1978.** Grossman, L. (Johns Hopkins Univ., Baltimore, MD (USA). School of Hygiene and Public Health). Jul 1978. Contract EY-76-S-02-2814. 13p. Dep. NTIS, PC A02/MF A01.

Our earlier work on the chemical basis of mutagenesis led to certain chemical generalities necessary to explain how certain mutagens such as UV light and hydroxylamine functioned in information transfer systems (replicative, transcriptive and translational). When such modifications were applied to biologically active DNA in a controlled manner biological expression was non-stoichiometric because much of the damage was removed from the DNA by repair systems. Our efforts were then directed to these systems which led to: the isolation, purification and characterization of endonucleases responsible for the first and controlling step in DNA repair referred to as incision in both M. luteus and E. coli; the isolation, purification and characterization of exonucleases responsible for the removal or excision of damaged nucleotides in M. luteus and human placental trophoblasts; the repair of UV damaged biologically active transforming and transfecting DNAs by purified endonucleases, exonucleases, DNA polymerase I and polynucleotide ligase from M. luteus and E. coli; the characterization of the dual gene control for incision phenomenon in M. luteus and E. coli; and isolation, purification and characterization of repair enzymes from human placenta.

IN MICROORGANISMS

REFER ALSO TO CITATION(S) 1489

IN ANIMALS

1486 (AD-A—051580) **Evaluation of a nuclease-resistant derivative of poly(i) poly(c) (poly(icIc)) as a radioprotective agent 1, 2. Interim report.** Baze, W.B.; Lvovsky, E.; Higbee, G.A.; Levy, H.B.; Hilmas, D.E. (Army Medical Research Inst. of Infectious Diseases, Frederick, MD (USA)). 1 Mar 1978. 26p. NTIS PC A03/MF A01.

The synthetic double-stranded ribonucleic acid, polyriboinosinic acid polyribocytidylic acid (poly(I) poly(C)) is an interferon inducer, has antiviral and antitumor properties, and has been shown to be radioprotective in rodents. The observation that the radioprotective action of poly(I) poly(C), as well as certain endotoxins and chemicals, may be associated with their ability to induce interferon, has also stimulated interest in the possible radioprotective action of interferon itself.

1487 **Microwave fixation of brain tissue as a neurochemical technique: a review.** Merritt, J.H.; Frazer, J.W. (USAF School of Aerospace Medicine, Brooks AFB, TX). *J. Microwave Power;* **12**: No. 2, 133-139(Jun 1977).

Microwave devices have been developed for rapidly inactivating brain enzymes by focusing the power output into the heads of small laboratory animals. The rapid inactivation achieved prevents postmortem changes and permits the measurement of neurochemicals such as acetylcholine at concentrations close to those obtained in vivo. The technique promises the assay of neurochemical parameters not possible before.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 1451, 1481, 1500

1488 **Continuation of mitosis after selective laser microbeam destruction of the centriolar region.** Berns, N.W.; Richardson, S.M. (Univ. of California, Irvine). *J. Cell Biol.;* **75**: No. 3, 977-982(Dec 1977).

The centriole regions of prophase PTK2 cells were irradiated with a laser microbeam. Cells continued through mitosis normally. Ultrastructural analysis revealed either an absence of centrioles or severely damaged centrioles at the irradiated poles. Microtubules appeared to focus into pericentriolar cloud material.

INTERNAL SOURCE

REFER ALSO TO CITATION(S) 1500

RADIATION EFFECTS ON MICROORGANISMS

1489 **DNA polymerase I-mediated ultraviolet repair synthesis in toluene-treated Escherichia coli.** Dorson, J.W.; Moses, R.E. (Baylor College of Medicine, Houston). *J. Biol. Chem.;* **253**: No. 3, 665-670(10 Feb 1978).

DNA synthesis after ultraviolet irradiation is low in wild type toluene-treated cells. The level of repair incorporation is greater in strains deficient in DNA polymerase I. The low level of repair synthesis is attributable to the concerted action of DNA polymerase I and polynucleotide ligase. Repair synthesis is stimulated by blocking ligase activity with the addition of nicotinamide mononucleotide (NMN) or the use of a ligase temperature-sensitive mutant. NMN stimulation is specific for DNA polymerase I-mediated repair synthesis, as it is absent in isogenic strains deficient in the polymerase function or the 5′ leads to 3′ exonuclease function associated with DNA polymerase I. DNA synthesis that is stimulated by NMN is proportional to the ultraviolet exposure at low doses, nonconservative in nature, and is dependent on the uvrA gene product but is independent of the recA gene product. These criteria place this synthesis in the excision repair pathway. The NMN-stimulated repair synthesis requires ATP and is N-ethylmaleimide-resistant. The use of NMN provides a direct means for evaluating the involvement of DNA polymerase I in excision repair.

1490 **Effects of 2.6 to 4.0 GHz microwave radiation on E-coli B.** Corelli, J.C.; Gutmann, R.J.; Kohazi, S.; Levy, J. (Rensselaer Polytechnic Inst., Troy, NY). *J. Microwave Power;* **12**: No. 2, 141-144(Jun 1977).

The effects of 2.6 to 4.0 GHz microwave radiation on living E. coli B bacteria were studied using measurement of the colony forming ability (CFA) of the cells and alterations in the molecular structure determined by comparing the infrared spectrum of irradiated and unirradiated cell cultures. At absorbed power levels of 20 mW in 1 ml of cellular suspensions (i.e., a specific absorption rate of 20 W/kg) for 10 to 12 hour exposures, no effects were observed on either the molecular structure or the CFA for this particular strain of E. coli.

BASIC STUDIES

REFER ALSO TO CITATION(S) 1451

1491 (COO—2066-31) **[Study of the mechanism of carcinogenesis by carcinogens which are negative in the Ames test]. Comprehensive report of overall activities for the past three years.** Borek, E. (Colorado Univ., Denver (USA). Medical Center). 1978. Contract EY-76-S-02-2066. 11p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following: DNA methylation and sensitivity of Escherichia coli to uv radiation; hormonal control of tRNA methyltransferases and tRNA structure; development of tRNA-dependent, in vitro protein synthesizing system from Ehrlich ascites cells; and effects of the carcinogens ethionine and carbon tetrachlorides on balance of estrogens and progestins in immature chicks. (HLW)

1492 (ORO—3408) **Annual progress report.** Powers, E.L. (Texas Univ., Austin (USA). Lab. of Radiation Biology). Jul 1978. Contract EY-76-S-05-3408. 15p. Dep. NTIS, PC A02/MF A01.

Progress is reported on the following research projects: sensitization of spores of Bacillus megaterium by metal ions; studies on platinum complexes; sensitization of bacterial spores to x radiation by copper compounds; uptake of Ag and Cd by spores; effects of various oxygen concentrations on transforming DNA; effects of Ag^+ on transforming DNA; uptake of Ag^+ by DNA; irradiation of spores

in the pulsed mode; and pulse radiolysis of DNA and DNA-metal complexes. (HLW)

1493 Inducible reactivation and mutagenesis of UV-irradiated bacteriophage P22 in Samonella typhimurium LT2 containing the plasmid pKM101. Walker, G.C. (Univ. of California, Berkeley). *J. Bacteriol.;* **135**: No. 2, 415-421(Aug 1978).

The inducible (Weigle) reactivation of uv-irradiated bacteriophage P22 has been examined in strains of Salmonella typhimurium with and without the mutagenesis-enhancing plasmid pKM101. A large inducible reactivation was observed in the plasmid-containing strain, but only a small response was observed in the strain lacking the plasmid. An increased frequency of clear-plaque mutants was detected among the survivors. The efficiencies of the plasmid-mediated and cellular repair processes have been determined. The kinetics of induction of the phage reactivation have been investigated. The relationship of the observed results to the inducible reactivation of uv-irradiated lambda in Escherichia coli and to error-prone repair is discussed.

1494 Effect of cold storage on inactivation of Escherichia coli by 313 nm irradiation. Newman, C. (Argonne National Lab., Ill. (USA)). *Photochem. Photobiol.;* **27**: No. 3, 363-365(Mar 1978).

Data are presented showing that the inactivation response of exponential phase Escherichia coli to 313 nm irradiation is affected by previous storage of cells at 3°C in M9 buffer. A similar effect of cold storage on the far-uv inactivation response was not observed. Cold storage alone causes on exponential loss in cell viability. After 0.95 days, cell viability is only about 15% of that observed immediately after exposure of cells to cold incubation. However, irradiation at 313 nm causes reactivation of these cold-inactivated bacteria.

RADIATION EFFECTS ON ANIMALS

1495 Prevention of ionizing radiation-induced liver microcirculation changes by the use of flow improvers. Bicher, H.I.; D'Agostino, L.; Doss, L.L.; Kaufman, N.; Amigone, J. (Roswell Park Memorial Inst., Buffalo). *Adv. Exp. Med. Biol.;* **94**: 383-389(1977).

Platelet aggregation and adhesiveness, as well as TpO_2 responses to hypoxia were measured as microcirculation parameters in beagle dogs subject to ^{60}Co ionizing radiation to a dose of 4600 rads in 5 weeks. Simultaneously, changes in blood chemistry and coagulation were also determined. Marked changes in all studied parameters in the post radiation period lead to the conclusion that the radiation liver damage, which is at least in part mediated through microcirculation disturbances, can be prevented with the flow improver, Rheomacrodex.

MAN

REFER ALSO TO CITATION(S) 385, 386, 1344, 1378, 1901

1496 (AD-A—051291) **Methodologies for evaluating the impact of time-variable nuclear effects on small unit combat operations. Final report, 15 May 1975—14 February 1976.** Brookman, M.A.; Hoffman, M.L. (BDM Corp., Vienna, VA (USA)). 4 Apr 1977. Contract DNA001-75-C-0281. 188p. (BDM/M—101-76-TR). NTIS PC A09/MF A01.

Two methods of assessing the impact of time-variable nuclear effects (TNE) on small-unit combat operations are examined. TNE is postirradiation performance degradation, short of death, and radiation-caused fatalities that occur a substantial time after irradiation. The first method examined is the modeling of human performance degradation from nuclear radiation, and the resulting impact on combat operations. The principal difficulties with this method stem from the fact that man's performance response to nuclear radiation is unknown. The second method examined is the use of degraded-performance units in troop training exercises, wherein commanders and their personnel can observe the impact of performance degradation on their capabilities. (Author)

1497 (INIS-mf—4198, pp v) **Working Group 6: Health. 1. Radioprotection.** Segaert, O. (GHENT RIJKSUNIVERSITEIT (BELGIUM)). Mar 1976. (In French).

In Compilation of reports [prepared by various working groups on the evaluation of problems of utilizing nuclear energy in Belgium].

The increasing development of nuclear energy needs the evaluation of risks associated with the use of radiation sources. Nuclear energy principles have therefore been defined and elaborated in order to limit the use of any radiation source as well as to reduce to a minimum the exposure either of workers or population to ionizing radiations and relative health hazards. Origin and extent of ionizing radiations and radioactive materials have been evaluated for electricity generating conventional and nuclear installations under normal functioning conditions as well as in case of an accident. More strict protective measures have been recommended for the production, utilization, and storage of plutonium containing fuel elements as well as for the treatment of radioactive wastes.

1498 (PNL—2663) **Technical guidelines for maintaining occupational exposures as low as practicable. Phase I. Summary of current practices.** Gilchrist, R.L.; Selby, J.M.; Wedlick, H.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Aug 1978. Contract EY-76-C-06-1830. 35p. Dep. NTIS, PC A03/MF A01.

Reducing radiation exposures to as low as practicable is a principle that was first introduced in 1949. However, the recent controversy over the low-level effects of radiation has led the Department of Energy (DOE) to review its programs. One such review was conducted by the Pacific Northwest Laboratory to survey the implementation of the ALAP principle in the DOE laboratories. This report contains the results of that survey, performed in 18 major DOE installations. The DOE contractors were asked questions concerning the following eight major areas: management, operational health physics, design, dosimetry, instrumentation, training, risk/cost-benefit, and impact of the ALAP philosophy. The survey revealed several potential areas of concern, which are described in this report. These areas will be addressed in the forthcoming manual, A Guide to Reducing Radiation Exposures As Low As Practicable (ALAP).

1499 United States population dose estimates for ^{131}I in the thyroid after the Chinese atmospheric nuclear weapons tests. Smith, J.M.; Broadway, J.A.; Strong, A.B. (Environmental Protection Agency, Montgomery, AL). *Science;* **200**: No. 4337, 44-46(7 Apr 1978).

Analysis of samples collected within the United States after the Chinese atmospheric nuclear weapons tests of 26 September and 17 November 1976 indicates that the radiation dose to the thyroid from iodine-131 in milk was predominant. A U.S. population dose to the thyroid of 68,000 man-rads was calculated for the iodine-131 fallout. The four excess thyroid cancers that are estimated to occur as a result of the September test during the next 45 years will be masked by the 380,000 cases of thyroid cancer which are expected to occur in the United States from all causes during the same interval.

1500 Radiation damage to mouse testis cells from [/sup 99m/Tc] pertechnetate. Mian, T.A.; Suzuki, N.; Glenn, H.J.; Haynie, T.P.; Meistrich, M.L. (M. D. Anderson Hospital and Tumor Inst., Houston, TX). *J. Nucl. Med.;* **18**: No. 11, 1116-1122(Nov 1977).

The radiation dose and the biologic damage to mouse testis from intravenously administered [/sup 99m/Tc] pertechnetate were studied. The dose was measured for penetrating radiations from /sup 99m/Tc, using calibrated thermoluminescent dosimeters and calculations from the uptake of the nuclide in the testis, and was found to be 4.9 rads per mCi of ^{99}Tc. The biologic damage was measured by the decrease in the number of sperm heads in the testis, counted both by hemacytometer and by Coulter counter. In preliminary experiments using external gamma radiation from ^{137}Cs, the number of sperm heads reached a minimum 29 days after irradiation. Twenty-nine days after injection of 5.8 mCi of /sup 99m/Tc, which gives 28 rads to the testis, the number of sperm heads decreased to 70% of control. The biologic effect corresponds to that seen after 40 rads of gamma radiation from ^{137}Cs. The damage to mouse testis cells from internally administered /sup 99m/Tc as measured in an in vivo system appears to be at least as significant as that from external gamma irradiation, if not more so.

VERTEBRATES

REFER ALSO TO CITATION(S) 1110, 1423, 1495

1501 Effects of whole-body irradiation on neonatally thymectomized mice. Incidence of benign and malignant tumors. Anderson, R.E.; Howarth, J.L.; Troup, G.M. (Univ. of New Mexico, Albuquerque). *Am. J. Pathol.;* **91**: No. 2, 217-227(May 1978).

The individual and combined effects of neonatal thymectomy and whole-body irradiation on the prevalence of benign and malignant tumors in germ-free female mice of the Charles Rivers line were studied to determine if a portion of the tumorigenic effects of irradiation can be attributed to injury of the thymic-dependent component of the immune response. Neonatal thymectomy increased (a) the incidence of benign and malignant tumors and (b) the prevalence of multiple primary neoplasms in an individual mouse. Whole-body exposure to 700 rad at 6 weeks of age further increased the incidence of tumors, but the relative magnitude of this increase was less pronounced than in sham-operated controls. Thus, the cumulative effects of thymectomy plus irradiation are less pronounced than the sum of the individual effects. One of several possible explanations for this observation is that a portion of the carcinogenic effects of whole-body irradiation is mediated by suppression of the thymic-dependent component of the immune response.

1502 Mammary and other tumors as a response to radiation and multiple stresses. Warren, S.; Brown, C.E. (Cancer Research Inst., Boston). *Arch. Pathol. Lab. Med.;* **102**: No. 5, 224-226(May 1978).

Parabiosis of paired NEDH rats and subsequent irradiation of one produced multiple stresses, particularly altered hormonal milieu. Benign mammary tumors developed in 8.6% of the control pairs, 12.7% of the shielded partners, and 19.7% of the irradiated rats. Mammary cancers developed in 5% of control pairs, 14.2% of the shielded partners, and 11.9% of the irradiated rats. With increased amounts of prolactin, the rate was 50% in shielded partners, 10% in the irradiated rats. Mesenchymal sarcomas develop at the anastomosis in parabiont rats. Their incidence rate in single controls is 3.1%, in parabiont control pairs 12.5%, in pairs with one partner irradiated 16.6%, and with both irradiated 23.1%. The incidence rate in other parts was increased threefold over controls in the irradiated partners. Radiation appears to be the dominant factor in both mammary and anastomotic tumors.

1503 Effects of leukocyte depletion on corneal neovascularization. Sholley, M.M.; Gimbrone, M.A. Jr.; Cotran, R.S. (Peter Bent Brigham Hospital, Boston). *Lab. Invest.;* **38**: No. 1, 32-40(Jan 1978).

The role of leukocytic infiltration in the initiation and maintenance of corneal neovascularization was studied in rats. Vascular ingrowth was induced by central cauterization of the cornea with silver nitrate and assessed after intraarterial perfusion of colloidal carbon. In normal rats, the mean vascular length was 0.33 mm at 3 days and 0.63 mm at 4 days. Whole-body x-irradiation with 800 rads depressed peripheral blood leukocyte counts to 1% of normal, prevented infiltration of monocytes, and reduced infiltration of neutrophils, but did not alter the neovascular response at 4 days. Combined treatment with radiation (800 rads) and repeated injections of antineutrophil serum (ANS) reduced peripheral leukocyte counts to nearly zero and eliminated infiltration of both monocytes and neutrophils. Despite the absence of leukocytes, neovascularization occurred in all corneas, However, the mean vascular length was reduced to 67% of control at 3 days and to 33% at 4 days. The results indicate that vascular growth can be initiated in the absence of leukocytic infiltration. The reduced neovascularization in totally leukopenic animals might be due to either the ability of neutrophils to facilitate or augment vascular growth or the nonspecific effects of treatment with radiation and antineutrophil serum.

1504 Lung mast cells and hypoxic pulmonary vasoconstriction in cats. Martin, L.F.; Tucker, A.; Munroe, M.L.; Reeves, J.T. (Univ. of Colorado, Denver). *Respiration;* **35**: No. 2, 73-77(1978).

An attempt was made to reduce or eliminate lung mast cells in order to determine the involvement of mast cells in hypoxic pulmonary vasoconstriction. Anesthetized cats were exposed to acute hypoxia (10% O_2) 20 to 24 h after no pretreatment, after total lung irradiation (3,000 r), after intravenous nitrogen mustard, or after combined lung irradiation and nitrogen mustard. None of the treatments reduced total or perivascular lung mast cell density, or reduced the pulmonary vasoconstrictor response to hypoxia. However, an inverse relationship between lung mast cell density and the pulmonary pressor response to hypoxia was observed. These results suggest that the presence of more lung mast cells may oppose hypoxic pulmonary vasoconstriction.

1505 Comparison of wound strength in normal, radiated, and infected tissues closed with polyglycolic and chromic catgut sutures. Barham, R.E.; Butz, G.W.; Ansell, J.S. (Univ. of Washington, Seattle). *Surg. Gynecol. Obstet.;* **146**: No. 6, 901-907(1978).

Wound strength in the rectus muscle of rabbits is greater at any measured time interval when sutured with polyglycolic acid than when sutured with chromic catgut. This is true for both irradiated and nonirradiated tissues. No significant advantage is seen for either suture in nonirradiated bladder, although the trend favors polyglycolic acid. In irradiated bladders, a significant advantage is seen for polyglycolic acid at 15 days. In measuring repaired ureteral orifice size, only chromic catgut suture in nonirradiated rabbits caused marked edema and ureteral obstruction. Postoperative ureteral dilation with both materials resolved over a 90 day period. In the irradiated ureter, however, resolution of this obstruction appears to occur earlier and more dependably when polyglycolic acid suture has been used. Polyglycolic acid showed a trend for superior strength in urothelial wounds tested. The healing of bladder epithelium is usually completed in ten to 14 days. The entire bladder wound gains strength rapidly until day 21 and gains little strength thereafter. A suture material that does not increase the inflammatory response but lasts long enough for complete bladder healing is advisable. Using the criterion of wound breaking strength in our experimental work, polyglycolic acid was shown to be superior to chromic catgut suture material.

1506 Experimental analysis of embryogenesis of cerebellum in rat. II. Morphogenetic malformations following x-ray irradiation on day 18 of gestation. Das, G.D. (Purdue Univ., Lafayette, IN). *J. Comp. Neurol.;* **176**: No. 3, 435-452(1 Dec 1977).

Rat embryos of 18 days gestation were exposed in utero to 170 R of x-ray irradiation. Embryos were collected six hours, 1, 2, and 3 days after irradiation, and animals of 2-, 6-, 15- and 30-day-old postnatal age were sacrificed. Six hours after irradiation pyknosis of cells was noticed in the external granular layer along the posterior aspect of the cerebellum. Neuroblasts, destined to differentiate into Purkinje cells, were found arrested in their migratory path. During subsequent periods of embryogenesis the external granular layer was found recovered, and clustering of the neuroblasts were disorganized and fragmented. This abnormal clustering of neuroblasts was permanent, and the external granular layer followed the same abnormal pattern in its growth. During postnatal development the internal granular layer also was found to follow the abnormal pattern of Purkinje cell layer. Those abnormal developmental events were seen to lead to malformed folia in the anterior regions of the cerebellum. In addition to it the cerebellum of x-ray irradiated animals appeared smaller than the normal. Issues having a bearing on the differential radiosensitivity of different cells, factors determining the small size of the cerebellum, and cellular events determining the morphogenetic malformations are discussed.

1507 Radiation injury in the neonatal canine kidney. I. Pathogenesis. Eisenbrandt, D.L.; Phemister, R.D. (Colorado State Univ., Fort Collins). *Lab. Invest.;* **37**: No. 5, 437-446(Nov 1977).

The effects of radiation on the developing canine kidney were investigated. Beagles were exposed to 330 R ^{60}Co gamma-radiation on the 2nd postnatal day of life. The kidneys were examined at 2 days (6 hours after irradiation), 4, 8, 14, 22, 70, and 200 days of age with qualitative and quantitative light microscopy and scanning electron microscopy. The primary result of the radiation injury was a failure to form the normal number of nephrons. The kidneys of irradiated dogs had 42 percent fewer nephrons (260,000) than the control dogs (445,000). In addition, extensive damage to forming nephrons produced dysplastic renal corpuscles and other corpuscles which were arrested in their development. Three mechanisms of radiation injury were identified. First, there was extensive mitosis-linked cell death in the nephrogenic zone. Second, mitotic delay resulted in only one-fifth of the normal mitotic activity in the nephrogenic zone through 2 days postirradiation. Third, there was an immediate and permanent cessation of nephron formation. The extensive injury in the outer renal cortex was compounded by the development of intercapillary glomerulosclerosis in some middle and inner cortical corpuscles by 200 days of age.

1508 Stimulation of dog thyroid by local application of high intensity micorwaves. Magin, R.L.; Lu, S.T.; Michaelson, S.M. (Univ. of Rochester, NY). *Am. J. Physiol.;* **233**: No. 5, E363-E368(Nov 1977).

Microwave radiation (2.45 GHz, CW) was applied locally to one of a dog's paired thyroid glands. The dog was anesthetized with sodium pentobarbital so that both glands could be surgically exposed and their caudal veins cannulated. The function of the thyroid glands was assessed by the measurement of total plasma thyroxine (T_4) in collected blood samples using a radioimmunoassay. The cannulated glands were allowed a 1-h equilibration period followed by a 2-h exposure period during which the temperature of the heated gland was maintained at approximately 39, 41, or 45°C. The thyroxine release rate (ng T_4/min) was determined from the difference between the T_4 concentration in the thyroid veins and femoral artery, the thyroid vein blood flow, and the hematocrit. The thyroxine release rate was increased during the exposure period to 150, 350, and 1,000% of the equilibration period means for the three temperatures studied. The blood flow was increased to 140 and 170% of the equilibration period means in the glands heated to 41 and 45°C. The contralateral control glands and sham-exposed glands maintained a constant thyroxine release rate. These results demonstrate that local heating of the thyroid gland can stimulate both thyroid gland blood flow and the release of thyroxine.

1509 Histologic effect of fractionated doses of selectively applied ^{60}Co irradiation to the teeth of albino rats. Sweeney, W.T.; Elzay, R.P.; Levitt, S.H. (Virginia Commonwealth Univ., Richmond). *J. Dent. Res.;* **56**: No. 11, 1403-1407(1977).

This study compares the effects of fractionated 2400, 4800 and 7200 rad doses of Co-60 irradiation on the formed and developing teeth of the rats. The 7200 rad dosage was found to cause damage to both odontoblasts and ameloblasts of developing incisors but to spare previously formed molars.

PEST CONTROL

1510 Recovery of chromosome aberrations from natural populations of corn earworms and tobacco budworms subjected to daily releases of partially sterile moths. North, D.T. (Agriculture Research Service, Fargo, ND); Snow, J.W. *J. Econ. Entomol.;* **71**: No. 2, 358-360(17 Apr 1978).

For cytogenetic study, testes of the larvae of corn earworm, Heliothis zea (Boddie), and tobacco budworm, H. virescens (F.),

were collected on St. Croix, U.S. Virgin Islands, from natural populations that had been subjected to daily releases of irradiated moths. Of the corn earworm larvae examined, 26.9% had at least one chromosome translocation, a fact which indicated some success in introducing inherited sterility into the population. In contrast, only one tobacco budworm out of 442 examined had a possible chromosome aberration. Either the budworm population was unaffected by the releases, or there was no survival of progeny from the partially sterile moths released. The hatch of field-collected eggs showed virtually no suppression of the budworm population that could be attributed to the releases. The study shows that a population can be sampled and examined cytogenetically to assess population suppression through genetic manipulation.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

REFER ALSO TO CITATION(S) 1376

1511 NRC rationale for bioassay requirements. Alexander, R.E. (Nuclear Regulatory Commission, Washington, DC). pp 293-299 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

The purpose of bioassays for uranium mill personnel is to get a base line on the amount of radioactivity in the worker's body. The word bioassay includes every measurement performed to evaluate the amount of radioactivity in the worker's body; urinalysis, fecal analysis, breath analysis, and in vivo measurements (whole body counter). A second purpose is exposure control. The most important area under exposure control occurs where bioassays are used as a check on the confinement of radioactive material and on the air sampling program.

ANIMALS

REFER ALSO TO CITATION(S) 1545

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 384, 1344, 1348

1512 Postprandial changes in the exhalation rate of radon produced in vivo. Rundo, J.; Markun, F.; Sha, J.Y. (Argonne National Lab., IL). *Science;* **199**: No. 4334, 1211-1212(17 Mar 1978).

The rate of exhalation of radon by persons with long-standing radium burdens increases about twofold shortly after a meal. The increase is short-lived and "normal" values are regained in 1.5 to 2 hours. The effect may account in part for the poor reproducibility in estimates of the freely emanating part of the radium content.

1513 In-vivo counting of uranium mill workers. Helgeson, G.L. (Helgeson Nuclear Services, Inc., Pleasanton, CA). pp 301-333 of Methods for measuring radiation in and around uranium mills. Harward, E.D. (ed.). Washington, DC; Atomic Industrial Forum, Inc. (1977).

From Workshop on methods for measuring radiation and around uranium mills; Albuquerque, NM, USA (23 May 1977).

Uranium-235 and daughter products ^{234}Pa and ^{234}Th activity was measured in the lungs of uranium mill personnel by external scintillation counters located in a mobile laboratory. The data generated were used to identify personnel with suspected high body burdens for further evaluation.

ANIMALS

REFER ALSO TO CITATION(S) 1377, 1423

1514 Model for local accumulation of bone imaging radiopharmaceuticals. King, M.A.; Kilpper, R.W.; Weber, D.A. (Univ. of Rochester, NY). *J. Nucl. Med.;* **18**: No. 11, 1106-1111(Nov 1977).

A simple model, having phenomenological parameters as variables, is developed for predicting local radioactive tracer accumulation in bone. Blood delivering tracer to one gram of bone is treated as a compartment separate from the remainder of the circulation in order to observe the effects produced by variations in both bone flow and barrier permeability. Kinetic curves derived by analog computer were obtained for normal and perturbed values of the parameters for F-18 and Ca-47 in a segment of rabbit bone. Apparent confirmation of the predicted influence of decreased blood flow on F-18 deposition was obtained by measuring bone uptake following constriction of the right femoral artery in five rabbits. Such models may prove useful in explaining variations in uptake for different agents, in selecting imaging times, and in correlating uptake patterns with disease.

PLANTS

1515 (ORNL-tr—4640) Absorption and distribution of strontium 90 and cesium 137 in wheat taken from a contaminated soil. Argiero, L.; Del Corso, G.; Manfredini, S.; Palmas, G. (Centro Applicazioni Militari Energia Nucleare, Pisa (Italy)). [nd]. Translation by S.D. Blalock Jr. of French paper. (CONF-621010—2). 10p. Dep. NTIS, PC A02/MF A01.

From Symposium on the retention and migration of radioactive ions in soils; Saclay, France (16 Oct 1962).

In order to study the sorption of ^{90}Sr and ^{137}Cs by wheat at different stages of growth, some seeds have been sown in little cases filled with earth materials containing various quantities of Ca and K. At different stages of growth, the earth materials containing various quantities of Ca have been contaminated with ^{90}Sr, the earth materials containing different quantities of K have been contaminated with ^{137}Cs. At the same time plant samples were taken at different stages of their growth, and their radioactivity was measured.

THERMAL EFFECTS

REFER ALSO TO CITATION(S) 1387

1516 Spatial distribution of nearshore fish in the vicinity of two thermal generating stations, Nanticoke and Douglas Point, on the Great Lakes. Minns, C.K.; Kelso, J.R.M.; Hyatt, W. (Fisheries and Marine Service, Burlington, Ont.). *J. Fish. Res. Board Can.;* **35**: No. 6, 885-892(Jun 1978).

At Nanticoke, Lake Erie, 1974, mean fish density varied considerably, range 162 to 14,204/10,000 m^3, as estimated by digital acoustic fish enumeration. At Douglas Point, Lake Huron, 1975, mean density varied less, range 108 to 671/10,000 m^3. At both sites fish densities were generally greatest in the shallowest, 3 to 5 m, depths. At Nanticoke, where the nearshore has low relief, there were no distinguishable communities. At Douglas Point, where depth increases rapidly offshore, there was evidence of benthic and pelagic communities. There was no evidence of altered fish distribution in relation to temperature. At Nanticoke there was no vertical variation in temperature and no vertical response was to be expected. At Douglas Point there was thermal stratification present in the summer and there was no apparent response. The influence of incident radiation was uncertain because of the effects of diurnal migrations. At both locations fish were clustered horizontally to varying degrees in the spring and fall, while in the summer fish were distributed more evenly. Densest clusters were usually in the vicinity of the turbulent discharge at both locations. The lack of temperature response and the similarity of Nanticoke with situations at nearby streams on Lake Erie suggest that the fish are responding to currents and perhaps topography.

1517 Increase in range of temperature tolerance by acclimation in the copepod Eurytemora affinis. Bradley, B.P. (Univ. of Maryland, Catonsville). *Biol. Bull.;* **154**: No. 2, 177-187(1978).

The copepod, Eurytemora affinis, was tested for its ability to recover from short exposures to a high temperature (temperature tolerance). Animals kept at a warm temperature for several hours or days before the test increased in tolerance (acclimation). Females showed higher tolerance and acclimation than males. Temperature tolerance was greater at a higher salinity (13 percent vs.0 percent), but acclimation was not. Analogous tests were done at low temperatures. Acclimation to cold temperature also occurred, but more slowly. Sexual differences were less marked than for heat tolerance. When tested on the same animals, heat and cold tolerances seemed to be positively related traits.

MICROORGANISMS

1518 Case of thermal pollution limited primary productivity in a southwestern U.S.A. reservoir. Stuart, T.J.; Stanford, J.A. (North Texas State Univ., Denton). *Hydrobiologia ;* **58**: No. 3, 199-211(26 Apr 1978).

North Lake, a small (330 ha. surface area) southwestern U.S.A. cooling water reservoir was found to contain less phytoplankton production (104.0 mg C m^{-3} day^{-1}), lower annual mean total organic carbon (3.7 mg l^{-1}) and phytoplankton standing crops (0.9 ml m^{-3}) than other local area reservoirs. Concentrations of

inorganic P and N were at or below test detection limits during the study year 1973-1974. In situ ^{14}C non-filtration primary productivity techniques demonstrated significant (approximately equal to 13%) stimulation of planktonic primary productivity due to power plant entrainment. Optical counts showed no destruction of entrained phytoplankters. Populations of Cyanophyta were never dominant, although they frequently bloom in most other local reservoirs. Thermal loading at North Lake is thought to ultimately depress phytoplankton primary production and standing crop by causing nutrient limitation.

1519 Survival and viability of Escherichia coli in a thermally altered reservoir. Gorden, R.W. (Univ. of Southern Colorado, Pueblo); Fliermans, C.B. (Savannah River Lab., Aiken, SC). *Water Res.;* **12**: No. 5, 343-352(1978).

Escherichia coli survived and grew in a warm, monomictic reservoir receiving thermal effluent from a nuclear production reactor, which suggests that the presence of E. coli in these aquatic systems is not an indication of recent fecal contamination. Known populations of E. coli were placed in sterile diffusion chambers and suspended at various depths throughout the water column. Experiments were conducted during both ambient water conditions (reactor not operating) and thermally altered water conditions (reactor operating). E. coli populations were observed for changes in density by using optical density and direct and indirect counting methods. During both ambient water and thermally altered water conditions, E. coli survived and grew 2 to 3 weeks at each depth and at all stations. During thermal alteration, cell populations attained higher optical densities and maintained those densities for longer time periods than those during ambient water conditions. In addition, populations suspended in the hypolimnion generally maintained higher optical densities than those in the epilimnion. Data show that E. coli survives and grows for extended periods of time while it is in diffusion chambers in both aerobic and anaerobic portions of the water column.

PLANTS

REFER ALSO TO CITATION(S) 1518

1520 Variations in the shallow water form of Potamogeton richardsonii induced by some environmental factors. Spence, D.H.N.; Dale, H.M. (Univ. of Guelph, Ont.). *Freshwater Biol.;* **8**: No. 3, 251-268(Jun 1978).

Populations of Potamogeton richardsonii in Sparrow Lake, Ontario, vary in leaf dimensions and internode length. Leaf length/breadth (L/B) ratio is increased by low irradiance, significantly at 4% daylight and, in a contrary fashion, by ontogenetic drift at high irradiances of shallow water. L/B was not correlated with substrate. This ratio is of doubtful value taxonomically or as an integrator of factors like photosynthetically active radiation (PAR). Longest internodes belong to plants from deep (1.8 m) water, and, in a summer-grown high-density population, internode length decreases logarithmically as depth lessens; both observations implicate PAR and aging. Relative to undisturbed, shallow-water shoots, young transplants in full daylight elongate almost twice as fast because of the production of more, and longer, internodes. Young shoots in 12% daylight lengthen even more rapidly than those in full daylight in the same period because of elongation of internodes. At ambient summer temperatures, this rate of elongation is inversely related to PAR. Maximal internode extension occurs on young shoots in very low irradiances at temperatures of 9 to 15°C; in nature, effects of increasing water temperatures are depressed by increasing irradiances and aging until minimal extension takes place in old shoots at mid- to late-summer temperatures and in high irradiances. In tanks (40 m^3) in full daylight, nutrients limit growth of plants on sand before they limit growth on clay (with marl intermediate); at 12% daylight, light limits growth on sand before soil nutrients do. The leaf area index on silty sand on an exposed shore was 0.4 at 0.5 m depth, in contrast to a cultured population where it was 4.0 in silty loam at the same depth.

INVERTEBRATES

1521 Effects of temperature on gut-loading and gut-clearing times of the burrowing mayfly, Hexagenia limbata. Zimmerman, M.C.; Wissing, T.E. (Miami Univ., Oxford, OH). *Freshwater Biol.;* **8**: No. 3, 269-277(Jun 1978).

The effect of temperature on gut-loading times, gut-clearing times, and the calculated ingestion rates, egestion rates, and consumption indices of the deposit-feeding burrowing mayfly, Hexagenia limbata, were investigated in laboratory experiments. Rates of movement of two natural sediments of differing color through the digestive tract were monitored to quantify feeding intensity when ambient water temperatures approached 5, 10, 15, 20, and 25°C. At each temperature, gut-loading times (GLT) and gut-clearing times (GCT) increased as nymph length increased. Mean GLT and GCT values decreased as temperature increased from 5 to 20°C but were longer at 25°C than at 20°C. Relationships between GLT, GCT, and length of nymphs and temperature were best described by multiple regression equations. No diel variation in gut-clearing times was observed. Low water temperatures resulted in lower ingestion and egestion rates and consumption indices. At most temperatures nymphs ingested over 100% of their dry body weights per day.

1522 Effects of growth and temperature acclimation on metabolic rate in the limpet, Cellana tramoserica (Gastropoda:Patellidae). Parry, G.D. (Univ. of Melbourne). *J. Anim. Ecol.;* **47**: No. 2, 351-368(Jun 1978).

Seasonal patterns in metabolic rate, somatic and gonadal growth rates were determined for the mid-littoral limpet Cellana tramoserica by field sampling and laboratory studies at regular intervals over 13 months. A predictive model of the seasonal changes in metabolic rate expected due to changes in growth rate was constructed on the assumptions that (i) at a particular temperature (15, 20, 25°C) the metabolic rate required for maintenance remained constant throughout the year; and (ii) the net efficiency of growth was 67%. The observed seasonal changes in metabolic rate closely fitted those predicted from changes in growth rate. Hence the concept of temperature acclimation is not necessary to explain the seasonal changes in metabolic rate of C. tramoserica. It is suggested that temperature acclimation of metabolic rate may in general be caused by temperature mediated changes in growth rate and not by a direct adaptation of metabolic rate to temperature.

1523 Response of the estuarine amphipod Gammarus daiberi to chlorinated power plant effluent. Ginn, T.C.; O'Connor, J.M. (New York Univ., NY). *Estuarine Coastal Mar. Sci.;* **6**: No. 5, 459-469(May 1978).

The amphipod Gammarus daiberi was subjected to plume drifts and laboratory exposures to chlorinated power plant cooling water effluent. Behavioral reactions to unchlorinated and chlorinated effluent were examined in an avoidance trough. During plant chlorination, the amphipods survived 1-h exposures to full-strength cooling water effluent (ΔT = 7.3 to 9.3°C, 0.05 m l^{-1} total chlorine). Test groups of G. daiberi drifted through the discharge plume during chlorination displayed no increased immediate or latent mortalities. One-hour static bioassays revealed an initial TL_{50} value of 1.85 mg l^{-1} total chlorine, which decayed to 0.2 to 0.5 mg l^{-1} during the exposure period. At ambient temperatures of 26.4 to 26.6°C, the amphipods avoided unchlorinated effluent at ΔT's $>$ 3.3°C. At lower ambient temperatures (15.3 to 15.7°C), no avoidance was observed at a 7.1°C ΔT. Chlorinated discharge water was avoided by G. daiberi at both ambient temperatures.

1524 Chilling and freezing resistance of two interstitial polychaetes from a sandy tidal beach. Westheide, W.; von Basse, M. (Univ., Goettingen, Ger.). *Oecologia (Berlin);* **33**: No. 1, 45-54(1978).

The two mesopsammal polychaetes, Hesionides arenaria and Trilobodrilus axi, show a relatively high resistance to cold temperatures in experiments. Great differences, however, between supercooled and frozen individuals exist. In chilling experiments T. axi is much less sensitive (no damage after 5 h at -12°C) than H. arenaria (50% mortality after 1 h at -7°C). The freezing resistance is essentially much less, but identical for the two species (100% mortality at -10°C after 1 h exposure). The differences in the supercooling resistance of the two species are in agreement with their geographic distribution and their seasonal migration behavior in the sandy beach locality.

VERTEBRATES

1525 Effects of temperature on the development and mortality of eggs of perch, Perca fluviatilis. Guma'a, S.A. (Windermere Lab., Eng.). *Freshwater Biol.;* **8**: No. 3, 221-227(Jun 1978).

The rate of development and mortality of perch Perca fluviatilis was studied at ten different constant temperatures. The rate of development was inversely related to the incubation temperature, whereas the rate of mortality was directly related to the incubation temperature. The sum of heat (SIGMA H, degree-days) required for 10, 50 and 90% of the eggs to hatch was found to be constant, regardless of the incubation temperature, with mean values (with 95% confidence limits) of 91.4 (83.3—102.0) degree-days above 4.6°C for 10% hatched, 97.0 (90.9—104.2) degree-days above 4.9°C for 50% hatched and 101.0 (94.3—108.7) degree-days above 5.0°C for 90% hatched. Mortality among the different embryological stages was highest for the pre-hatching stage (i.e., when eye-pigment has been formed) at all temperatures. High mortality among the early stages occurred at temperatures below 8°C and above 12°C.

1526 Temperature dependence of active metabolism and swimming speed of the Baikal grayling, Thymallus arcticus baicalensis. Stolbov, A.Ya.; Alikin, Yu.S. (Inst. of Physiology, Novosibirsk, USSR). *J. Ichthyol. (Engl. Transl.);* No. 1, 178-179(1977).

Investigated is the influence of temperature on oxygen consumption in the Baikal grayling, Thymallus arcticus baicalensis, at rest and at different speeds of swimming. The grayling, a stenothermal species, living at comparatively low temperatures, is adapted to active swimming at high speeds.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 1391, 1434, 1483

1527 Marine environmental impact due to mining activities of El Salvador copper mine, Chile. Castilla, J.C.; Nealler, E. (Universidad Catolica de Chile, Santiago). *Mar. Pollut. Bull.;* **8**: No. 3, 67-70(Mar 1978).

Marine environmental impact as a result of copper mine tailing dumping in the sea is studied at Chanaral (North of Chile). These dumpings, from the copper mine El Salvador, have hindered harbor activites, caused geomorphological coastal modifications and affected seriously marine coastal ecosystems and recreational activities. At the old dumping site, Chanaral Bay (1938 to 1974), nearly 150 million tons of fine sediments were accumulated. Tailing discharges at the new dumping site, Caleta Palito, about 8 km north of Chanaral Bay are accumulating approximately at the rate of 25,000 tons of fine sediments per day, plus unknown quantities of chemicals (Cu, As, CN^-). From January 1975 to July 1976, this site has received over 13 million tons of sediments which has caused deterioration of the marine coastal environment, reduction in light penetration and high mortalities among marine invertebrates, fishes and algae.

1528 Role of prostaglandin E2 in zinc absorption in the rat. Song, M.K.; Adham, N.F. (Veterans Administration Hospital, Sepulveda, CA). *Am. J. Physiol.;* **234**: No. 2, E99-E105(Feb 1978).

The supernatant of cytoplasmic extract of rat small intestine was mixed with ^{65}Zn and subjeted to Sephadex G-75 column chromatography. The activity of ^{65}Zn was detected in four peaks with estimated 800, 10,000, 50,000 to 75,000 mol wt, and larger than 100,000 daltons. The zinc-binding ligand from the 800 mol wt peak was prostaglandin or prostaglandin-like as indicated by ultra-violet absorption spectrum, by absorption spectrum shift in alcoholic potassium hydroxide, by its effects on pulmonary vascular resistance, and by radioimmunoassay. Addition of prostaglandin E2 or prostaglandin extracted from rat small intestine with ethyl acetate into the lumen of intestinal sacs resulted in a two to threefold increase in the activity of ^{65}Zn in the external medium after 15 to 20 min incubation. The absorption and tissue distribution of orally administered ^{65}Zn were decreased by 60% in indomethacin-treated rats and increased 70% when ethyl acetate-extracted prostaglandin and radioactive zinc were given simultaneously. These data suggest that prostaglandin not only binds zinc, but also facilitates its transport across the intestinal mucosa.

1529 Acute effect of Bunker C oil and an oil dispersant on: 1 serum glucose, serum sodium, and gill morphology in both freshwater and seawater acclimated rainbow trout (Salmo gairdneri). McKeown, B.A.; March, G.L. (Simon Fraser Univ., Burnaby, British Columbia). *Water Res.;* **12**: No. 3, 157-163(1978).

Bunker C oil and an oil dispersant were tested for physiological stress on both freshwater and saltwater acclimated rainbow trout. Both compounds tended to reduce serum glucose levels with Bunker C causing the more significant decrease (P less than 0.08), indicating a possible dysfunction of the kidney. The freshwater treatment group showed a significant decrease in sodium levels (P less than 0.01) when treated with a dispersant, while under similar conditions, saltwater acclimated fish show a very marked increase in serum sodium concentrations (P less than 0.025). Those fluctuations in sodium levels are resultant from direct interference with the energy activated sodium transport systems of the gills. Microphotographs of gill filaments and lamellae show severe damage caused by the dispersant and dispersant/oil mixture with less impairment resultant from Bunker C exposure.

CELLS

REFER ALSO TO CITATION(S) 1480

1530 (ORNL/TM—6390) **Short term bioassay and bioassay chemistry of materials related to synthetic fossil fuels.** Guerin, M.R.; Epler, J.L.; Gehrs, C.W. (Oak Ridge National Lab., TN (USA)). Jul 1978. Contract W-7405-ENG-26. 134p. Dep. NTIS, PC A07/MF A01.

An abstract was prepared for one paper. Abstracts of the five additional papers appeared previously in ERA.

MICROORGANISMS

REFER ALSO TO CITATION(S) 1432, 1476, 1530, 1563

1531 Microorganisms and petroleum pollutants. Atlas, R.M. (Univ. of Louisville, KY). *Bioscience;* **28**: No. 6, 387-391(Jun 1978).

Microorganisms play an important natural role in removing polluting petroleum hydrocarbons from contaminated ecosystems. Environmental conditions and hydrocarbon composition influence biodegradation of contaminating oil. Microbial seeding and environmental modification can be used, in certain situations to enhance biodegradation, as part of an overall program aimed at controlling oil pollution.

1532 Telemediators in the marine environment. Aubert, M.; Aubert, J.; Gauthier, M. (Institut National de Sante et de la Recherche Medicale, Nice). *Mar. Pollut. Bull.;* **9**: No. 4, 95-97(Apr 1978).

In an article in which authors express their own opinions about current events, the concept that the behavior of marine organisms is influenced by the indirect action of other organisms in the same environment is considered in terms of telemediators. These are substances synthesized by marine organisms and released into the environment where they act remotely on behavior of the same or other species. Typical examples of telemediators are discussed. The authors state that telemediation should only be considered ecologically true when the chemical mediator has been demonstrated in the natural oceanic environment and can be shown to be active when isolated. There are two telemediation mechanisms, the primary one in which the chemical telemediator controls metabolism of another species. A secondary type consists of a telemediator synthesized by one species controlling a metabolic function in another species which, in turn, acts upon a third species. A combination of these two produces feedback processes which control interspecific equilibria. The telemediator may act as a metabolite toward the receiving organism or as a signal or, in the language of genetics, a message. The authors consider that such chemical interactions probably control marine life; such a concept should be the basis for detailed studies. Also emphasized is the fragility of such mechanisms and the potential risks to biological equilibria from chemicals such as those contained in industrial wastes.

1533 Controlled ecosystem pollution experiment: effect of mercury on enclosed water columns. VIII. Summary of results. Grice, G.D. (Woods Hole Oceanographic Institution, MA); Menzel, D.W. *Mar. Sci. Commun.;* **4**: No. 1, 23-31(1978).

In a summary of previous experiments conducted in plastic enclosures Menzel (1977) pointed out that the initial effects of pollutants on the biota appeared similar regardless of the pollutant tested. His remarks were based largely on a series of experiments performed in small enclosures (68 m^3) for periods up to 30 days. The papers included in this and the preceding issue of this journal document the reactions to mercury of plankton communities maintained in 1300 m^3 plastic enclosures for a period of 72 days.

1534 Controlled ecosystem pollution experiment: effect of mercury on enclosed water columns. VII. Inhibition of nitrogen assimilation and ammonia regeneration by plankton in seawater samples. Harrison, W.G. (Bedford Inst. of Oceanography, Dartmouth, Nova Scotia); Renger, E.H.; Eppley, R.W. *Mar. Sci. Commun.;* **4**: No. 1, 13-22(1978).

Additions of mercury at concentrations >1 $\mu g\ l^{-1}$ to natural samples of coastal seawater resulted in the inhibition of nitrate and ammonia assimilation (by phytoplankton) and ammonia regeneration (by bacteria and/or microzooplankton) in short-term (24 to 48 hr) experiments. Phosphate uptake was similarly affected. Synthesis of nitrate reductase was stimulated by low concentrations of mercury and inhibited by higher concentrations (>1 $\mu g\ l^{-1}$).

1535 Controlled ecosystem pollution experiment: effect of mercury on enclosed water columns. VI. Denitrification by marine bacteria. Koike, I. (Tokyo Univ.); Hattori, A.; Goering, J.J. *Mar. Sci. Commun.;* **4**: No. 1, 1-12(1978).

Sixty-two day effects of 5 $\mu g\ l^{-1}$ mercury on denitrification by natural populations of marine bacteria in large volume (1300 m^3) Controlled Experimental Ecosystems (CEES) were investigated using ^{15}N labeled nitrate as a tracer. Denitrifying activities, i.e., N_2 production, 27 days after addition of mercury were similar in bottom water and in newly formed sediments in a CEE containing 5 $\mu g\ l^{-1}$ mercury (Hg CEE) and one with no mercury (Control CEE). After 62 days the denitrifying activity in Hg CEE sediments exhibited a six fold higher half saturation constant (K/sub m/) for nitrate than did the control CEE sediments. Apparently a selection for denitrifying bacteria with a high K/sub m/ occurs when natural populations of marine denitrifiers are exposed to 5 $\mu g\ l^{-1}$ mercury for two months.

PLANTS

REFER ALSO TO CITATION(S) 1321, 1453

1536 Effect of buffered solutions and various anions on vegetative and sexual development in gametophytes of Pteridium aquilinum. Evans, L.S. (Manhattan Coll., Bronx, NY); Bozzone, D.M. *Can. J. Bot.;* **56**: No. 7, 779-785(1 Apr 1978).

Experiments were performed to determine the effects of chloride, nitrate, and sulfate in buffered solutions on sperm motility and fertilization in gametophytes of Pteridium aquilinum. Buffered solutions with various anions simulated exposures to acidic precipitation up to 3.5 h. The presence of each anion decreased both sperm motility and fertilization. Addition of 43.3 μM sulfate (equivalent to the sulfate concentration in rain of northeastern United States) decreased sperm motility about 40% compared with plants exposed to buffers without sulfate. Additions of 86.6 μM and 173.2 μM sulfate gave sperm motility levels of approximately 45% and 36% of sperm unexposed to sulfate. Percentage reduction in sperm motility during sulfate exposure was independent of buffer pH. Additions of chloride and nitrate at pH 4.8 gave sperm motility values similar to buffers with sulfate. However, at pH 5.8, chloride ions were less harmful than nitrate or sulfate. Addition of anions also had a detrimental effect on fertilization or production of sporophyte plants. In all experiments, the presence of chloride and nitrate alone or in combination with sulfate gave reductions in fertilization similar to that of sulfate alone at equivalent concentrations. Additions of one or more anions produced additive effects at all pH levels to reduce both sperm motility and fertilization in gametophytes of Pteridium aquilinum.

1537 Effect of fertilization on a pine forest ecosystem in an industrial region. II. Sulfur content and some morphological characters of the needles. Olszowski, J.; Warteresiewicz, M. (Forest Research Inst., Katowice, Poland). *Ekol. Pol.;* **24**: No. 3, 299-306(1976).

The effect of treatment with fertilizers on the morphological characters studied was most evident during the second growing season following the application of the fertilizers. In fertilizer-treated plots an increase in dry weight and average needle length was found, as also an increase in the length of annual stem growth and the number of needles over the growth. As a result of the treatment with fertilizers there occurred a clear reduction in the level of sulphur in the needles, the differences persisting for two years. On the basis of the above findings and the measurements made, it may be assumed that some morphological characters and the content of sulphur in the needles may be used as diagnostic indicators for the evaluation of the fertilizer-treatment applied in industrial regions.

1538 Effect of fertilization on a pine forest ecosystem in an industrial region. VII. Summary of the studies. Olszowski, J. (Forest Research Inst., Katowice, Poland). *Ekol. Pol.;* **24**: No. 3, 359-363(1976).

A 3-years' wide-scope research series into the effect of fertilization on a pine forest was carried out in the environs of Katowice (Silesia). The series included the following studies: I—Forest stand volume increment, II—Sulphur cntent and some morphological characters of the needles, III—Herbs, IV—Macromycetes, V—Chemical properties of the soils, VI—Biological activity of the soils.

INVERTEBRATES

REFER ALSO TO CITATION(S) 1398, 1523

1539 Influence of ozone on pea aphid resistance in selected alfalfa strains. Elden, T.C.; Howell, R.K.; Webb, R.E. (Agriculture Research Service, Beltsville, MD). *J. Econ. Entomol.;* **71**: No. 2, 283-286(17 Apr 1978).

Ozone-treated plants of 5 strains of alfalfa, Medicago sativa L., were compared with untreated plants for resistance to Acyrthosiphon pisum (Harris). Treated plants were exposed to 20 pphm ozone for 4 h at 26°C, 92% RH, and an illumination of 21.5 KLx (2000 ft-c). After 48 h, they were scored on a numerical scale for ozone injury. Ozone-treated and untreated plants were then evaluated for pea aphid resistance by caging 4 adult females on each plant for 7 days and then recording adult survival, living nymphs, and dead nymphs. Higher levels of ozone resistance were confirmed in alfalfa entries that had previous cycles of selection in the greenhouse for air pollutant resistance. The variety "Team" and the experimental population MSA-CW3An3, 2 of the 3 entries with higher levels of ozone resistance, also displayed higher levels of pea aphid resistance. MSB-CE5An3 also was resistant to ozone but not to the pea aphid. The varieties "Mesa-Sirsa" and "Williamsburg" were susceptible to both ozone and the pea aphid. Ozone injury had little or no effect on alfalfa resistance to pea aphids as expressed by numbers of surviving adults, living nymphs, and dead nymphs.

1540 Effect of heavy metals on the survival, reproduction, development, and life cycles for two species of polychaetous annelids. Reish, D.J.; Carr, R.S. (California State Univ., Long Beach). *Mar. Pollut. Bull.;* **9**: No. 1, 24-27(Jan 1978).

The effects of exposure of six metals on survival and reproduction in two species of polychaetous, Ctenodrilus serratus and Ophryotrocha diadema, possessing short life histories were measured. The suppression of reproduction was generally two orders of magnitude less than the 96 h LC_{50}.

1541 Uptake of water-soluble gasoline fractions and their effect on oxygen consumption in aquatic stages of the mosquito (Ades aegypti (L.)). Berry, W.O.; Brammer, J.D.; Bee, D.E. (Univ. of Vermont, Burlington). *Environ. Pollut. (London);* **15**: No. 1, 1-22(Jan 1978).

Oxygen consumption in aquatic stages of the mosquito (Aedes aegypti (L)) was measured following a 24-h pretreatment in sublethal doses of water-soluble fractions from whole gasoline or its individual components (benzene, toluene and xylenes). A significant increase in O_2 consumption occurred in treated-fed larvae following exposure to water-soluble fractions from either 1 ml gasoline/liter water or a mixture of 0.2 ml benzene and 0.2 ml toluene/litre water. No significant differences in respiration were observed in either unfed larvae or fed larvae pretreated with the separate fractions or combinations of xylenes with benzene or toluene. Uptake and discharge of toluene by 4th-instar larvae were measured in solutions containing water-soluble amounts of H^3 toluene alone and in combination with benzene. These experiments suggest that water-soluble gasoline fractions are taken up by food particles and assimilated by the insects via feeding. The respiratory response of the larvae appears to be due to a synergistic effect of benzene and toluene that may affect cell permeability.

1542 Long-term study of the effects of water-soluble fractions of No. 2 fuel oil on the survival, development rate, and growth of the mud crab Rhithropanopeus harrisii. Laughlin, R.B. Jr.; Young, L.G.L.; Neff, J.M. (Texas A and M Univ., College Station). *Mar. Biol.;* **47**: No. 1, 87-95(1978).

Mud crabs, Rhithropanopeus harrisii (Gould), were exposed continuously for 6 months after hatching to water-soluble fractions (WSF) of No. 2 fuel oil. Survival, growth and development rate were monitored during this time. The zoeal stages were the most sensitive to fuel oil. A 20% WSF (0.36 ppM total naphthalenes, 1.26 ppM total hydrocarbons) was acutely toxic to these stages. Of the zoeal stages, the first stage appeared to be the most sensitive. The combined duration of the 4 zoeal stages was significantly increased by increasing WSF exposure concentrations. The megalopa and crab stages were not particularly sensitive to continued petroleum hydrocarbon exposure, particularly when compared to zoeal stages. However, mean duration of the megalopa and first crab stages was significantly affected by oil exposure. Individuals which survived the highest exposure concentrations as larvae appeared to grow larger during the crab stages, so that at the end of 6 months comparably staged crabs were equal to or larger than both control crabs and those exposed to low WSF concentrations. Stage distributions at the end of 6 months showed no differences due to WSF exposure. Sex ratios, which could be determined at the end of 6 months, were approximately 1, indicating no sex-related differential sensitivity to WSF exposure, at least as larvae or juveniles. The data indicate that these crabs possess considerable ability to recover from the effects of chronic sublethal exposure to petroleum hydrocarbons. The most deleterious effects of oil pollution on this species may be due to its impact on larval recruitment into the adult population.

1543 Effects of cadmium and mercury on the behavioral responses and development of Eurypanopeus depressus larvae. Mirkes, D.Z.; Vernberg, W.B.; DeCoursey, P.J. (Univ. of South Carolina, Columbia). *Mar. Biol.;* **47**: No. 2, 143-147(1978).

Larval stages of the estuarine mud crab Eurypanopeus depressus were exposed to either 10 ppB cadmium or 1.8 ppB mercury in a flow-through rearing system. Development time from the megalopa to juvenile crab was extended in the cadmium-exposed individuals. Cadmium elevated the swimming rates of the late zoeal stages, while mercury depressed swimming rates of the early stages. Increased mortality of Stage I zoeae was observed after 24 h exposure to cadmium; increased mortality was also noted for megalopa and early crab stages reared in cadmium.

VERTEBRATES

REFER ALSO TO CITATION(S) 1408, 1431, 1504, 1563, 1568

1544 (LBL—7460) Superimposition of carbon dioxide on acute isobaric hypoxia: plasma erythropoietin, acid-base status, and P_{50} in the unanesthetized rabbit. Wolf-Priessnitz, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1978. Contract W-7405-ENG-48. 70p. Dep. NTIS, PC A04/MF A01.

Thesis.

Major factors affecting changes of the arterial Hb—O_2 affinity (P_{50}) were examined in relation to the initiation of erythropoietin (ESF) production in unanesthetized New Zealand white male rabbits. They were exposed to an isobaric hypoxic environment (8.8 percent O_2) with and without CO_2 (5.6 percent or 10 percent). During 5 hrs exposure, samples of arterial blood were collected for measurements of plasma ESF titers; whole-blood pH, P/sub CO2/, S/sub O2/, lactate, pyruvate, and P_{50}; and intraerythrocytic 2,3-DPG, ATP and ADP. Exposure to 8.8 percent oxygen alone stimulated ESF production and caused a leftward shift in the in vivo P_{50}; the addition of CO_2 significantly inhibited ESF production and blocked the shift in P_{50}/sub (i.v.)/. The data suggest that increased oxygenation of the whole-body tissues occurs with exposure to 8.8 percent O_2 + CO_2 as reflected by lower whole-blood excess lactate accumulation. In keeping with the prevailing theory, the suppression of ESF production is probably a result of this increased oxygenation.

1545 Chronic ingestion of cadmium and/or tritium in rats. I. Accumulation and distribution of cadmium in two generations. Pietrzak-Flis, Z.; Rehnberg, G.L.; Favor, M.J.; Cahill, D.F.; Laskey, J.W. (Environmental Protection Agency, Research Triangle Park, NC). *Environ. Res.;* **16**: No. 1-3, 9-17(Jul 1978).

Sprague-Dawley rats continuously ingested low levels of Cd(0.1 to 5.1 ppM) or tritiated water from conception of the F_1 through delivery of the F_2 generation. Analyses of tissues at various ages during treatment showed that (1) blood is a poor indicator of chronic exposure history; (2) the placenta was an efficient barrier to Cd transfer to the fetus, permitting detectable levels of Cd in neonatal organs only at the highest exposure level; (3) milk does not appear to be an important source of neonatal exposure; (4) the postnatal accumulation rate of the metal appeared hightest during preweaning stages; and (5) during prolonged ingestion, Cd levels in liver and kidney were roughly proportional to exposure while little accumulation was noted in brain and testes.

1546 Correlation of respiratory parameters in hamsters with the lung deposition of radiolabeled cigarette smoke. Rubin, I.B.; Gill, B.E.; Guerin, M.R.; Kendrick, J.; Nettesheim, P. (Oak Ridge National Lab., TN). *Environ. Res.;* **16**: No. 1-3, 70-76(Jul 1978).

An evaluation was made of the relationship between respiration and deposition of cigarette smoke particulate matter in the lungs of Syrian golden hamsters. The hamsters were exposed to radiolabeled cigarette smoke while their respiratory rates and tidal volumes were monitored and recorded. The amount of total particulate matter deposited in the lungs correlated linearly with the respiratory parameters. For all tests, the sample correlation coefficient for lung deposition with minute volume was 0.75, with tidal volume, 0.84, and with respiratory rate, 0.52. Respiration characteristics of hamsters that had been smoking for 6 months were measured during their course of 12 daily cigarettes. The average volume and rate measurements during the smoke periods were essentially the same as for the beginning hamsters.

1547 Behavioral observations in squirrel monkeys (Saimiri sciureus) following methylmercury exposure. Joiner, F.E.; Hupp, E.W. (Texas Woman's Univ., Denton). *Environ. Res.;* **16**: No. 1-3, 18-28(Jul 1978).

Squirrel monkeys were exposed to methylmercuric chloride in various doses (0.0, 2.0, 3.0, 4.0 mg/animal or 3.0, 4.5, 6.0 mg/kg) and observed for general behavioral changes, electrophysiological changes, and quantitative changes in a Wisconsin General Test Apparatus (WGTA). Animals receiving high, medium, and low doses (6.0 mg/kg, 4.0 mg/animal, 4.5 mg/kg, and 3.0 mg/animal) showed signs of mercury poisoning including diminished activity, decreased food consumption, increased errors, latency, and duration in the WGTA, motor problems, and blindness. Electroretinograms (ERG) of blind and sighted animals were unimpaired. Severity of mercury poisoning was related to behavioral effects.

1548 Comparative irritant potency of sulfate salts. Amdur, M.O.; Bayles, J.; Ugro, V.; Underhill, D.W. (Harvard Univ., Boston). *Environ. Res.;* **16**: No. 1-3, 1-8(Jul 1978).

Guinea pigs were exposed for a period of 1 hour to aerosols of sulfate salts. With the exception of sodium sulfate, all the sulfates caused a slight increase in pulmonary flow resistance and a slight decrease in pulmonary compliance. The order of irritant potency was ammonium sulfate > ammonium bisulfate > cupric sulfate. All the sulfate salts were less irritant than sulfuric acid. The particle size range was limited (0.1 to 0.8 μm, mass median diameter), but, in general, the degree of response increased with decreased size. Of the four sulfates tested, only copper sulfate potentiated the response to sulfur dioxide. The possible practical implications of these findings are discussed.

1549 Influence of cadmium, nickel, and chromium on primary immunity in mice. Graham, J.A.; Miller, F.J.; Daniels, M.J.; Payne, E.A.; Gardner, D.E. (Environmental Protection Agency, Research Triangle Park, NC). *Environ. Res.;* **16**: No. 1-3, 77-87(Jul 1978).

The effects of metals on the primary humoral immune system of mice were investigated using a hemolytic plaque technique to determine the number of specific antibody-producing spleen cells. Inhalation of $NiCl_2$ for 2 hr resulted in a significant negative linear dose response, the lowest effective concentration tested being 250 μg of Ni/m³. Following a 2 hr aerosol exposure to $NiCl_2$, the lung cleared Ni on a first-order kinetics basis. A significant reduction in the number of plaques per 10^6 cells also was observed with exposure to 190 μg of Cd/m³. Analyses of the data from intramuscularly exposed mice indicated that concentrations greater than or equal to 3.90 μg of Ni/g body weight (as $NiSO_4$) and greater than or equal to 9.25 μg of Ni/g body weight (as $NiCl_2$) resulted in significant immunosuppression. Intramuscular treatments with NiO, $CdCl_2$, and $CrCl_3$ had no effect at the concentrations tested.

1550 Embryotoxic effects of chromium trioxide in hamsters. Gale, T.F. (Medical Coll. of Georgia, Augusta). *Environ. Res.;* **16**: No. 1-3, 101-109(Jul 1978).

Chromium trioxide was administered iv at 5, 7.5, 10, and 15 mg/kg to pregnant golden hamsters early on the 8th gestation day. Fetuses were collected from the treated females on the 12th, 14th, and 15th gestation days and examined for the frequency and types of external, internal, and skeletal malformations. It is concluded that exposure of hamsters to this chemical form of a ubiquitous metallic element can kill fetuses in utero and produce edema and retardation as well as specific malformations in surviving fetuses. The most interesting malformations included cleft palate and defects in the ossification of the skeletal system. The results are discussed in relation to other teratogenic agents with particular emphasis on mechanisms of cleft palate formation.

1551 Elevated heavy metals: a stress on a population of white suckers, Catostomus commersoni, in Hammell Lake, Saskatchewan. McFarlane, G.A.; Franzin, W.G. (Freshwater Inst., Winnipeg, Manitoba). *J. Fish. Res. Board Can.;* **35**: No. 7, 963-970(Jul 1978).

This study examined populations of white suckers, (Catostomus commersoni), in two physically and chemically similar lakes in the vicinity of, and receiving heavy-metal fallout from, a base-metal smelter complex near Flin Flon, Manitoba. The white suckers occupying Hamell Lake, Saskatchewan, which is contaminated by Zn, Cu, and CD, showed signs typical of a population under stress when compared with the population in Thompson Lake, Manitoba, which contains much lower levels of these metals. Hamell Lake white suckers showed greatly increased growth in length and weight, increased fecundity, and earlier age of maturation, but reduced spawning success, reduced larval and egg survival, smaller egg size, and reduced longevity compared with Thompson Lake white suckers. We attribute these differences to elevated heavy metals in Hamell Lake waters, particularly in early spring, a most critical period in the reproductive cycle of these fish. Effects of the metals on other species of fish in Hamell Lake are also discussed.

1552 Copper sensitivity of Pacific herring, Clupea harengus Pallasi, during its early life history. Rice, D.W. Jr.; Harrison, F.L. (Univ. of California, Livermore). *Fish. Bull.;* **76**: No. 2, 347-356(Apr 1978).

Embryos and larvae of the Pacific herring, Clupea harengus pallasi, were exposed to copper, using a flow-through bioassay system. Herring embryos were exposed continuously from 12 h after fertilization until hatching, and larvae were exposed from the time of hatching until yolk sac absorption. Embryos were also exposed to 36-h duration pulses of copper in order to evaluate the sensitivity of different developmental stages of herring embryos to copper. Pulsed exposures started at 62, 98, or 136 h after fertilizaton. The following measurements were taken as indices of the toxic effects of copper: cumulative mortality, percent hatching, and larval length upon hatching. The onset of mortality of herring embryos continuously exposed to copper began 90 h after fertilization, with deaths occurring over a short interval thereafter (response period). Significant embryo mortalities occurred at a copper concentration as low as 35 μg/l. Herring larvae continuously exposed to copper showed significant mortality at 300 μg/l copper, with no delay in the onset of mortality. Embryos exposed to 36-h pulses of copper during different developmental stages showed reduced sensitivity when exposed after the response period. Larvae that hatched from eggs exposed to a 36-h pulse of copper before the response period grew significantly less than those hatched from eggs exposed during later developmental stages.

1553 Fetal effects of cadmium in pregnant rats on normal and zinc deficient diets. Parzyck, D.C.; Shaw, S.M.; Kessler, W.V.; Vetter, R.J.; Van Sickle, D.C.; Mayes, R.A. (Purdue Univ,. Lafayette, IN). *Bull. Environ. Contam. Toxicol.;* **19**: No. 2, 206-214(Feb 1978).

This investigation has shown that not only the extent of fetal resorption and malformation but also the types of malformation seen in rats depend upon the strain used and day of gestation. Furthermore, the effects of zinc deficiency and cadmium administration on

the fetus can be at least additive, as was seen for malformations. For fetal resorption, zinc deficiency potentiated the action of cadmium.

1554 Toxicity of coal-conversion gasifier condensate to the fathead minnow. Schultz, T.W.; Davis, S.; Dumont, J.N. (Oak Ridge National Lab., TN). *Bull. Environ. Contam. Toxicol.;* **19**: No. 2, 237-243(Feb 1978).

The mortality rate of minnows exposed to various concentrations of gasifier condensate suggests two modes of action. Based on observations of behavior and gill pathology, it is felt that fish die at high concentrations (0.5 to 0.1%) due to nervous paralysis and at lower concentrations due to general tissue necrosis and/or organ failure.

1555 Lead contamination of small mammals from abandoned metalliferous mines. Roberts, R.D. (Liverpool Univ.); Johnson, M.S.; Hutton, M. *Environ. Pollut. (London);* **15**: No. 1, 61-69(Jan 1978).

Spoil tips associated with abandoned non-ferrous mines contain anomalously high levels of heavy metals compared with other contaminated environments. Little attention has been given to the impact of such contaminated environments on terrestrial ecosystems. In this study, lead in soil, vegetation, ground-living invertebrates and indigenous small mammal populations are reported for two derelict mines in Wales. Small mammal body and tissue lead concentrations were markedly elevated compared with control populations and with published data for other lead-contaminated areas. Oedema, intranuclear inclusion bodies and mitochondrial abnormalities--symptoms of clinical plumbism--were identified in kidney tissue in populations with highest tissue lead concentrations. The results and their relevance to other lead-contaminated areas, including roadside verges, are discussed.

1556 Report on cadmium and freshwater fish. *Water Res.;* **12**: No. 4, 281-283(1978).

Cadmium is widely used in industry and small quantities are discharged to surface waters and are largely adsorbed onto suspended solids. Soluble forms are toxic to fish. Cadmium is accumulated in fish primarily by gills, liver and kidney. Cadmium may impair osmoregulation. It is eliminated slowly. Acute and chronic toxicity tests with fish have given conflicting results; if a threshold lethal concentration exists, it is ill-defined. A decrease in water hardness, dissolved oxygen, and possibly pH value produces a lower LC50. Changes in temperature and salinity may also influence toxicity of cadmium. Sensitivity is different among different fish species: in general salmonids are more sensitive than are cyprinids. Juvenile stages are more sensitive than adults. Few sub-lethal effects have been observed; some are: spinal deformities in minnows, impaired oogenesis in trout, increased activity of males during spawning with resultant increased mortality. Most invertebrates are less sensitive to cadmium than are salmonids. Some aquatic plants show inhibition of growth, but most plants are resistant. Cadmium pollution is usually accompanied by other toxic materials. Tentative criteria for dissolved cadmium are given. Reliable field data from polluted and unpolluted rivers and experimental ecosystems are needed to reinforce these criteria. The concentration of cadmium in fish muscle after long exposure to low levels is highly variable and can be between 1 and 1000 times higher (dry weight basis) than that in the water. The reasons for these wide variations are not known.

1557 Zinc and copper in bone and teeth of mice. Fosse, G.; Justesen, N.P.B. (Univ., Bergen). *Int. J. Environ. Stud.;* **12**: No. 2, 111-120(1978).

Zinc and copper levels of femurs, incisors and molars of mice having a normal, optimal supply of the metals were recorded at the ages of 120 and 210 days. At both ages Zn-levels were highest in molars, while femur levels were higher than those of incisors. In all three tissues there was a statistically significant decrease with age. Cu-levels were highest in molars, and incisor-levels were higher than those of femurs. In femurs and incisors the Cu-levels were about double with age, while the increase was more than five-fold in molars. Fourteen mice had combined additional supply of 500 μg Zn/g and 200 μg Cu/g in drinking water. Seven of them were killed at the age of 120 days. Seven of them were returned to normal supply of the metals at the age of 120 days and were killed at the age of 210 days. The first seven had slightly higher Zn-levels than control mice in femurs and incisors, while molar-Zn was more than doubled. In the older mice that previously had had additional metal supply this higher molar-Zn level remained unchanged, whereas femur- and incisor-Zn had returned to the levels of the youngest controls. In all 14 mice that had received hyperoptimal metal doses, hard tissue Cu-levels were unaffected and were similar to those of controls at both ages. It was concluded that deciduous human teeth can be used as indicators of hyperoptimal Zn-absorption, but they will perhaps not indicate hyperoptimal Cu-absorption.

1558 Metabolism and toxicity of acrylonitrile. Gut, I.; Kopecky, J.; Nerudova, J.; Holecek, V. *Prac. Lek.;* **28**: No. 4, 110-118(1976).

A review is presented of the literature and authors' own findings on the biotransformation and toxicity of acrylonitrile (AN). The following topics are discussed: physical and chemical properties of AN; AN reactivity and its biotransformation; metabolism; acute lethal effects; effects on nervous system, pulmonary system, liver, urinary system, cardiovascular system, blood and skin, cumulative effects of AN; AN poisonings; mechanism of AN toxic effects; determination of AN, rhodanides and cyanides.

MAN

REFER ALSO TO CITATION(S) 129

1559 Blood clearance half-times in lactating and nonlactating members of a population exposed to methylmercury. Greenwood, M.R.; Clarkson, T.W.; Doherty, R.A.; Gates, A.H.; Amin-Zaki, L.; Elhassani, S.; Majeed, M.A. (Univ. of Rochester, NY). *Environ. Res.;* **16**: No. 1-3, 48-54(Jul 1978).

An epidemic of methylmercury poisoning occurred in rural Iraq early in 1972 due to the ingestion of homemade bread prepared from wheat treated with a methylmercury fungicide. We report observations of the blood mercury clearance half-times of lactating women and nonlactating groups who were exposed during the epidemic. Blood clearance half-times calculated by linear regression analysis show that in lactating females, the mean half-time is 42 days and in nonlactating females and males, the mean half-time is 75 days. Experiments in mice also show such differences in whole body half-time: 5.6 days in lactating females and 9.3 days in nonlactating females.

1560 Assessment of the contribution of chemical species to the eye irritation potential of photochemical smog. Altshuller, A.P. (Environmental Protection Agency, Research Triangle Park, NC). *J. Air Pollut. Control Assoc.;* **28**: No. 6, 594-598(Jun 1978).

Eye irritation measurements are available from smog chamber solar irradiations of selected hydrocarbon-nitrogen oxide mixtures. These results have been used to compute eye irritation intensity parameters for formaldehyde, acrolein, peroxyacetyl nitrate, and peroxypropionyl nitrate. Peroxypropionyl nitrate is the most irritating of these four substances. The relative contribution of various pairs of eye irritants in ambient air mixtures to eye irritation has been calculated from the ambient air concentrations and the eye irritation intensity parameters. The relative contribution of the four eye irritants to a "typical" ambient air mixture has been computed. Formaldehyde appears to be the single most significant eye irritant. Other potential ambient air eye irritants are discussed. The relationships between the hydrocarbon control strategies and eye irritation are considered.

1561 Problem of benzene in our environment: clinical and molecular considerations. Cohen, H.S.; Freedman, M.L.; Goldstein, B.D. (New York Univ., NY). *Am. J. Med. Sci.;* **275**: No. 2, 125-136(1978).

Medical effects of benzene are reviewed. Primary emphasis is given to chronic effects on the hematopoietic system and on research of effects at the molecular level.

1562 Morphine metabolism in opiate dependent and normal men by double isotope techniques. Hahn, E.F.; Roffwarg, H.; Fishman, J. (Inst. for Steroid Research, Bronx, NY). *Res. Commun. Chem. Pathol. Pharmacol.;* **18**: No. 3, 401-414(Nov 1977).

A mixture of morphine-^{63}H and morphine-N-$^{14}CH_3$ was administered to an opiate dependent and to a normal male subject. In both subjects the urinary excretion of radioactivity was rapid and exceeded 85% of the dose over 72 hours. The extent and time pattern of N-demethylation differed in the two subjects with N-demethylation of morphine being slower and less in the opiate addict. The use of the double isotope technique in detecting small changes in morphine metabolism is discussed.

1563 Genetic risk of epichlorhydrin as related to occupational exposure. Sram, R.J.; Cerna, M.; Kucerova, M. *Biol. Zentralbl.;* **95**: No. 4, 451-462(1976).

The mutagenic activity epichlorhydrin was studied using the recommended system of chemical testing. Its mutagenic activity was proved on Salmonella typhimurium strain G 46 and TA 100 with and without metabolic activation in vivo, by cytogenetic analysis of bone marrow cells in mice and in human peripheral lymphocytes exposed in vitro. The dominant lethal test in mice evidenced no increase in comparison to the controls. The findings indicate that epichlorhydrin has the potential of being genetically hazardous for humans. Anticipated annual occupational exposure is estimated to correspond to about 7.1 mg epichlorhydrin per kg. It is assumed that this dose is below the maximum permissible level of genetic damage.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

1564 (CONF-780541—1) **Methods for studying and criteria for evaluating the biological effects of electric fields of industrial frequency.** Savin, B.M.; Shandala, M.G.; Nikonova, K.V.; Morozov, Yu.A. (AN SSSR, Moscow. Inst. Khimicheskoj Fiziki). 1978. 24p. Dep. NTIS, PC A02/MF A01.

From Criteria for evaluating the biological efforts; Paskeut, USSR (15 May 1978).

Data are reviewed from a number of USSR research studies on the biological effects of electric power transmission lines of 1150 Kv and above. Effects on man, plants, animals, and terrestrial ecosystems are reported. Existing health standards in the USSR for the exposure of personnel working in electric fields are included. It is concluded that high-voltage electric fields have a harmful effect on man and his environment.

1565 (TID—28696) **Preliminary study of the behavioral and biological effects of high intensity 60 Hz electric fields. Quarterly technical progress report, No. 1.** (Southwest Research Inst., San Antonio, TX (USA)). 1 Aug 1978. Contract ET-78-C-01-2875. 61p. Dep. NTIS, PC A04/MF A01.

The major objective of this preliminary study is to develop and thoroughly test the experimental protocols and apparatus, which are planned for a major study of the behavioral and biological effects of high intensity 60 Hz electric fields. The behavior of baboons will be observed before, during, and after exposure to 60 Hz electric fields at a maximum intensity of 60 kV/m. Both individual performance (operant conditioning) and social behavior will be examined. The preliminary study will differ from the planned major study as follows: subjects will be used as their own controls; a smaller number of subjects will be run; field intensity will not be varied; the electric field should be non-uniform; the preliminary study exposure facility will be basically an outdoor facility; to avoid deterioration of plastic materials, the high intensity fields will not be turned on during or just after rainfall; and in the preliminary study the biological work will be restricted to the clinical determination of the health of subjects before and after exposure. The present report is the first of three quarterly technical progress reports. It covers approximately the first two and one-half months of activity and, therefore, consists primarily of plans. The report addresses four major areas: the high intensity field exposure facility; the field measurement instrumentation; the operation conditioning equipment; and experimental methods including experimental design and data analysis.

1566 (JPRS—71136) **Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.** 18 May 1978. Translation of USSR articles. 55p. NTIS.

The report contains information on aerospace medicine, agrotechnology, bionics and bioacoustics, biochemistry, biophysics, environmental and ecological problems, food technology, microbiology, epidemiology and immunology, marine biology, military medicine, physiology, public health, toxicology, radiobiology, veterinary medicine, behavioral science, human engineering, psychology, psychiatry and related fields, and scientists and scientific organizations in biomedical fields. Individual entries were made for the various items.

1567 (JPRS—71136, pp 1-5) **Effects of low-frequency (50 Hz) electromagnetic field on functional state of the human body.** Dumanskii, Yu.D.; Popovich, V.M.; Kozyarin, I.P. 18 May 1978. Translated from Gig. Sanit.; No. 12, 32-35(1977).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

In areas over which powerlines (PL) pass, intensive, industrial frequency electromagnetic fields (IFEMF) are generated, and their voltage can reach 18 to 20 kV/m (1150 kV PL). For this reason, it is now imperative to set standards for this factor, even for individuals unrelated to servicing PL. In a study of conditions under which the public is exposed to PL zones, it was determined that several standards should be set, in particular, in the case of regular, brief exposure (2 to 3 h/day) and brief (incidental) exposure (up to 30 min). In order to determine the criterion for exposure time, particularly for agricultural workers, in an IFEMF zone, we collected information concerning the time spent by the people in this zone, in the course of agricultural work. We found that such work is seasonal (sowing time, caring for crops, harvesting, etc.). As a rule, it lasts for 3 to 5 days at a time and is associated with exposure for 25 to 30 min, 2 or 3 times a day, to the IFEMF zone. It is known that data obtained from observations of physiological reactions of the body among those exposed to the factor in question, which inform us about the extent to which it affects the body, are the most valuable and convincing for substantiation of hygienic standards. In view of the foregoing, we conducted several series of observations of the physical condition of volunteers in order to study the distinctions of biological effects of IFEMF of varying intensity.

1568 (JPRS—71136, pp 15-19) **Distinctive reactions of the body's immunological system to the combined effects of physical and chemical environmental factors.** Vinogradov, G.I. (Kiev Scientific Research Inst. of General and Municipal Hygiene). 18 May 1978. Translated from Gig. Sanit.; No. 10, 28-31(1977).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

As shown by the results obtained, the combined effect of formaldehyde and EMF, regardless of EFD level, led to a reliable depression of all phagocytic indices studied and complement titer. These changes were characterized by stability, and they did not disappear in the subsequent 4-week observation period. When we analyzed the data referable to complement-fixation under refrigeration and cellular reactions, we were impressed by the absence of an allergenic effect, again regardless of the intensity of prior irradiation. Evidently, in this case, it could be attributed to the desensitizing effect of microwaves and competition of tissue antigens, occurring as a result of the combined effect of chemical and physical factors. Exposure of carbon-monoxide-treated animals to 50 $\mu W/cm^2$ SHF EMF led to stimulation of the phagocytic reaction and elevation of complement titer in blood serum after termination of irradiation. The level of this stimulation was the same as observed in the case of exposure to 50 $\mu W/cm^2$ microwaves alone. A less marked elevation of indices of nonspecific immunity was observed in the case of exposure to 5 $\mu W/cm^2$ microwaves. Four weeks after termination thereof, the indices of immunological reactivity reverted to the base level in both cases. Thus, exposure of animals to microwaves after carbon monoxide aided in normalization of function of the immunological system.

1569 (JPRS—71136, pp 20-23) **Effect of electromagnetic fields on enzyme activity.** Arber, S.L. 18 May 1978. Translated from Elektron. Obrab. Mater.; No. 1, 63-65(1978).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

The result we have obtained may be applied to enzyme catalysis, since the formation of the enzyme-substrate complex is the rapid step of the reaction, representing an ordinary chemical process, and the macromolecular nature of one of the reagents has no effect upon its course. As is well known, it is the precise orientation of the catalytic groups which is necessary for enzyme catalysis, and when the groups are polar the effect of fields will slow the enzyme reaction. Proceeding from this result, it is possible to explain the fact that certain enzymes have decreased activity in electromagnetic fields, while the activity of others remains insensitive to microwave irradiation. Clearly an effect of the field on a polar substrate too must be considered possible.

1570 (JPRS—71136, pp 24-30) **Reaction of central and peripheral mediator elements of the sympathoadrenal system to single exposure to alternating magnetic field.** Sakharaova, S.A.; Ryzhov, A.I.; Udintsev, N.A. (Tomsk Medical Inst., USSR). 18 May 1978. Translated from Biol. Nauki.; No. 9, 35-39(1977).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

Phasic changes were demonstrated in levels of catecholamines and dopa in the central and peripheral mediator elements of the sympathoadrenal system following single exposure to an alternating magnetic field for 24 h. In the first phase there was increased uptake of dopamine and epinephrine in the brain stem, norepinephrine in the hypothalamus, intensified transfer of epinephrine from blood to the heart and liver, and increased norepinephrine content of the liver and spleen. In the second phase, the epinephrine level remains low in brain stem tissues, norepinephrine content remains high in the liver and spleen and reverts to normal in the heart and hypothalamus. In the third phase, catecholamine levels drop in all organs with the exception of the heart.

1571 (JPRS—71136, pp 31-38) **Copper, molybdenum, iron, and manganese metabolism in rat tissues in response to a 50 Hz electric field.** Gabovich, R.D.; Kozyarin, I.P.; Mikhalyuk, I.A.; Fesenko, L.D. (Kiev Medical Inst.). 18 May 1978. Translated from Ukr. Biokhim. Zh.; No. 2, 206-211(1978).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

It is established that chronic exposure to an electric field causes changes in the metabolism and distribution of copper, molybdenum, iron, and manganese in rat organs and tissues, with the expression of these changing depending on field intensity.

1572 (JPRS—71136, pp 39-44) **Evaluation of hygienic significance of electric field of power lines in populated areas.** Kozyarin, I.P.; Popovich, V.M. . (Kiev Medical Inst.). 18 May 1978. Translated from Vrach. Delo; No. 11, 120-124(1977).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

The experimental animals were put in special cages, with simulation of a 50 Hz field generated by means of high-voltage oil-tank transformers. We performed physiological and biochemical tests prior to the experiment, monthly and 30 days after "irradiation" (recovery period). They included examination of organs and physiological systems that are the most sensitive to electromagnetic fields. We studied the functional state of the nervous and endocrine systems, immunological indices, some aspects of metabolic processes, morphological composition of peripheral blood, glycogen content of the liver, cholinesterase activity in brain tissue, vitamin C content of the adrenals, histomorphological structures of viscera, etc.

1573 (JPRS—71136, pp 45-48) **Effect of electromagnetic field on growth and development of plants.** Bel'skii, A.I. 18 May 1978. Translated from Elektron. Obrab. Mater.; No. 6, 69-71(1977).

In Translations on USSR Science and Technology: Biomedical and Behavioral Sciences No. 28. Effects of nonionizing electromagnetic radiation.

The results of our experiments revealed that Bastard Michurina, Korotkonozhka nursery plants and Antipka seedlings grow slower and there is 10 to 12 cm less increment of runners per vegetation than in the control when they are in the zone of a strong electromagnetic field. Fruit-bearing began in the 2nd to 3rd year after planting, whereas in controls it began in the 4th to 5th year. The yield over the years of our studies (1961-1966) was higher in the hothouse box, which contained 10 trees of each variety (15% higher for Vladimirskaya cherry, 18% for Bastard Michurina and 25% for Korotkonozhka). In the hothouse box with electromagnetic field, cherry, tomato, pepper and corn seedlings were one-third shorter than controls, the blades were smaller but more intensively colored. The plants in the electromagnetic field were more resistant to fungal diseases and injuries referable to pests, since living organisms alter their migratory behavior and reaction to stimuli under the influence of the field. Plants situated in the center of the electromagnetic field, i.e., closer to the electric cable, had more chlorotic leaves. In the region of mild effects of the electromagnetic field, the plants grew faster, the crowns of seedlings and nursery plants of cherry developed in a vase shape under the influence of the electromagnetic field, unlike the spherical and pyramid-shaped ones in the control. The runners and leaves tended to follow the direction corresponding to the action of forces of the electromagnetic field. In the case of superposition of electromagnetic waves, when 2 cables, with a section of phi 80 mm are situated next to one another at a distance of 4 m, depress growth, the plants became dwarfed, with a clumped and deformed crown.

1574 **Tolerances of fishes to dissolved gas supersaturation in deep tank bioassays.** Fickeisen, D.H.; Montgomery, J.C. (Battelle-Pacific Northwest Labs., Richland, WA). *Trans. Am. Fish. Soc.;* **107**: No. 2, 376-381(1978).

Four species of fish were tested for tolerance to dissolved atmospheric gas supersaturation in 10-day bioassays. Based on median times to death at four levels of gas saturation, the fish displayed the following increasing order of tolerance: mountain whitefish (Prosopium Williamsoni) < cutthroat trout (Salmo clarki) < largescale sucker (Catostomus machrocheilus) < torrent sculpin (Cottus rhotheus). Increasing hydrostatic pressure due to water depth reduced the levels of saturation of dissolved gases and increased survival. Torrent sculpins typically developed large bubbles of gas which caused them to float and would contribute indirectly to death.

HEALTH AND SAFETY

1575 (AECB—1119(Rev.1)) **Risk of energy production. Second edition.** Inhaber, H. (Atomic Energy Control Board, Ottawa, Ontario (Canada)). May 1978. 169p. Dep. NTIS (U.S. Sales Only), PC A08/MF A01.

Every form of human activity involves risk of accident or disease, resulting in injury or death. Generation of energy is no exception. Although such risk has previously been considered for conventional systems (coal, oil and nuclear), a similar analysis for the so-called alternative or non-conventional systems (solar, wind, ocean thermal and methanol) has been lacking. This paper presents an evaluation of the risk, both occupational and to the public, of these non-conventional energy systems. They are considered both in absolute terms and in relation to conventional systems. The risk of most non-conventional systems, per unit of energy output, is comparable to, and in some cases much higher than, the risk from coal and oil. This conclusion holds whether we consider deaths or injuries. Nuclear power and natural gas had the lowest overall risk of the eleven technologies considered. Ocean thermal energy ranked third. The surprising result is that the other eight technologies considered were found to be up to 100 times less safe. While a solar collector on the roof appears to be completely innocuous as it silently absorbs sunlight, there is considerable risk inherent in the industrial processes used to construct this device. Per unit of energy output, the solar collector requires a significantly larger input of construction material than conventional systems. Fabricating and installing the systems also introduces risk. The total risk is calculated by considering six components: material acquisition and construction, emissions caused by material production, operation and maintenance, energy back-up energy storage, and transportation. In this way the risk of widely different systems can be fairly assessed. This methodology of "risk accounting" will not tell us which energy technology to use. However, it can be employed to inform society of the risk inherent in competing energy systems.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 257, 259, 1578

1576 (NVO—1253-13) **Interaquifer leakage through uncased boreholes penetrations, Yucca Valley, Nevada Test Site. DRI Publication No. 45013.** Fenske, P.R. (Nevada Univ., Reno (USA). Center for Water Resources Research). May 1978. Contract EY-76-C-08-1253. 18p. Dep. NTIS, PC A02/MF A01.

A method of calculating groundwater leakage rate into the carbonate aquifer through uncased boreholes is presented. An estimate of leakage rate over a long time interval rather than early transient calculations is required, and the appropriate basic equations are the straight line solutions of the radial flow equations. Aquifer parameters were estimated on the basis of a few measured values. The leakage rate through one unplugged uncased borehole into the Carbonate Aquifer is of the same order as the total natural leakage through the Tuff Aquitard. The effect of enhanced leakage rate will be to increase the transport rate of tritium if an uncased unplugged borehole is near an expended nuclear test in the Alluvial Aquifer or Tuff Aquitard.

1577 (RHO-BWI-C—10) **Bibliography of the geology of the Columbia Basin and surrounding areas of Washington with selected references to Columbia Basin geology of Idaho and Oregon.** Tucker, G.B.; Rigby, J.G. (Washington State Dept. of Natural Resources, Olympia (USA)). Mar 1978. Contract EY-77-C-06-1030. 475p. Dep. NTIS, PC A20/MF A01.

This bibliography is a compilation of all known published, unpublished, and open file references dealing with the geology and geophysics of the Columbia Basin of eastern Washington. Bibliographic entries were obtained primarily from the WDGER and Washington State libraries. The "Geo-Ref" bibliographic system was also utilized. Although all fields of geology have been included, the emphasis of the literature search was placed on the basalt stratigraphy of the Columbia Basin, late Cenozoic sediments overlying the basalt, structural geology, tectonics, and seismicity. Every effort was made to see that the bibliography is complete. The sections on Idaho and Oregon are known to be incomplete, as the focus of the bibliographic search was on Washington State.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

1578 (NUREG/CR—0074) **Data from selected accelerograph stations at Wilshire Boulevard, Century City, and Ventura Boulevard, Los Angeles, California.** (Shannon and Wilson, Inc., Portland, OR (USA); Agbabian Associates, El Segundo, CA (USA)). Jun 1976. 294p. NTIS $11.75.

Seismic and geotechnical data for 11 accelerograph stations located in three parts of Los Angeles are presented. Four stations each are situated near Wilshire Boulevard and Century City, while the three remaining stations are located on Ventura Boulevard. Near the Wilshire Boulevard stations, a 400-foot deep boring reveals that this region is underlain by about 30 feet of alternating layers of hard clays and dense sands. Below 30 feet, hard silty clay was encountered for the full depth of the boring. Five of six shallow borings drilled by others in the region classify these materials as weathered

rock (siltstones and shales). Seismic shear wave velocities of 2500 feet per second were determined below a depth of approximately 200 feet. At Century City, the four accelerograph stations are underlain by interbedded layers of stiff to hard clays and silts and dense to very dense sands to a depth of about 80 feet. Between depths of 80 and 130 feet a very dense sand was encountered with a shear wave velocity, increasing with depth, from 1000 to 2000 fps. Below 130 feet, the soil gradually grades with depth from a very dense, silty sand to a hard, sandy, clayey silt. Seismic shear wave velocities are about 2000 feet per second below 130 feet. At depths greater than 305 feet, these velocities reach 2500 feet per second. At the Ventura Boulevard stations, the upper 65 feet of soil consists of interlayered dense sands and silts and stiff to hard clays. Below 65 feet to a depth of 320 feet (termination depth of boring B-3), the materials are classified as hard silty clays, clayey silts and sandy silts, or weathered fractured shale. The seismic shear wave velocities in these materials range between 1800 and 2300 fps below a depth of 150 feet. Included are descriptions of each accelerograph station, discussion of the seismicity of each region, and a catalog of seismic events. Also, selected ground motion-time histories and their corresponding response spectra are provided.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 381

1579 (LBL—7052) **Large scale permeability test of the granite in the stipa mine and thermal conductivity test. Technical project report No. 2.** Lundstroem, L.; Stills, H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1978. Contract W-7405-ENG-48. 38p. Dep. NTIS, PC A03/MF A01.

The investigated properties of the granite bedrock at Stripa may be summarized as follows: The permeability is very low, 0.4 x 10^{-10}m/s, and independent of the pressure gradient. The permeability is reduced by 50 percent at a temperature increase from +10°C to +35°C. The thermal conductivity was determined in situ to be about 4 W/m°C which largely agrees with laboratory determinations. The effective porosity was determined to be 0.012 percent. 12 figs.

1580 (RHO-BWI-C—11) **Preliminary report on physical and thermal properties of basalt: Drill Hole DC-10, Pomona Flow, Gable Mountain.** Duvall, W.I.; Miller, R.J.; Wang, F.D. (Colorado School of Mines, Golden (USA). Earth Excavation Inst.). May 1978. Contract EY-77-C-06-1030. 46p. (SA—907). Dep. NTIS, PC A03/MF A01.

A summary of the results of mechanical and thermal tests on the first series of basalt core received from the Pomona Flow, Drill Hole DC-10 is presented. A discussion of the testing procedures and test results, with recommendations for future testing, is also included.

1581 (Y/OWI/TM—32) **Creep model for salt.** Russell, J.E. (Union Carbide Corp., Oak Ridge, TN (USA). Office of Waste Isolation). May 1978. Contract W-7405-ENG-26. 23p. (CONF-780564—2). Dep. NTIS, PC A02/MF A01.

From 5. international salt symposium; Hamburg, F.R. Germany (29 May 1978).

The time-dependent behavior of natural rock salt is of interest from several points of view which include the geological questions related to the genesis of anticlines, spines, domes, and other diapiric structures, as well as, the more practical questions related to the exploitation of petroleum and natural gas resources and the exploitation of the rock salt for commercial use. In addition, knowledge of the creep behavior of rock salt is of paramount importance in underground storage applications of petroleum products and nuclear wastes. The purpose of this paper is to generally discuss the time-dependent response of salt, to propose a one-dimensional model for this behavior, and to illustrate the model's capacity to simulate creep behavior using constant strain-rate test data.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 1397, 1424

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

REFER ALSO TO CITATION(S) 1275

COSMIC RADIATION

REFER ALSO TO CITATION(S) 1705

1582 (PPPL—1459) **Propagation of cosmic rays through a plasma.** Kulsrud, R.M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1978. Contract EY-76-C-02-3073. 12p. Dep. NTIS, PC A02/MF A01.

The theory of the coupling of energetic particles to a plasma by Alfven wave instabilities is described. The theory is applied to the problem of propagation of cosmic rays through the interstellar plasma and to the problem of trapping of cosmic rays in an expanding bubble of plasma produced by a supernova explosion.

1583 **Search for tachyon monopoles in cosmic rays.** Bartlett, D.F.; Soo, D.; White, M.G. (Department of Physics and Astrophysics, University of Colorado, Boulder, Colorado 80309). *Phys. Rev., D;* **18**: No. 7, 2253-2261(1 Oct 1978).

We have searched for a particle which combines the properties of a tachyon with those of a magnetic monopole. The tachyon monopole is assumed to exist in cosmic rays striking the earth and to be influenced by the extensive magnetic fringing field of Fermilab's 15-ft. bubble chamber. By hypothesizing that the tachyon monopole will either emit Cherenkov radiation in air or ionize Lexan plastic we set an upper limit of 5 x 10^{12} cm^{-2} sec^{-1} on their flux.

1584 **Diffusion approximation to neutrino transport in dense matter.** Bludman, S.A.; Van Riper, K.A. (Department of Physics, University of Pennsylvania). *Astrophys. J.;* **224**: No. 2, 631-642(1 Sep 1978).

The Eddington diffusion approximation to neutrino transport is derived paying careful attention to induced absorption and scatterng, both elastic and inelastic. Rosseland means for energy and neutrino number transport by both scattering and absorption are calculated analytically, for arbitrary neutrino degeneracy eta. In neutrino transport out of a stellar core, the neglect of neutrino inelasticity in scattering is justified, except during the initial neutrino thermalization phase. Two appendices treat (A) the equation of state of a neutrino-antineutrino gas and (B) exact expressions for even and odd combinations of the Fermi integrals F/sub k/(eta).

1585 **Mean mass of the abundant cosmic-ray nuclei from boron to silicon at 1.2 GeV per atomic mass unit.** Dwyer, R. (Enrico Fermi Institute and Department of Physics, University of Chicago). *Astrophys. J.;* **224**: No. 2, 691-707(1 Sep 1978).

We present the results of a comprehensive study of cosmic-ray isotopic composition above 1 GeV per amu. The mean mass of the elements B, C, N, Ne, Mg, and Si over the energy range 1.0—1.6GeV per amu and the implications for the cosmic-ray sources are given. The technique used employs the effect of the geomagnetic field on the cosmic-ray fluxes. The principle of the method is discussed, and details on the data analysis procedures are given. The instrument is a scintillation—liquid Cerenkov counter telescope with a multiwire proportional chamber hodoscope. It has been flown twice on high-altitude ballons from Palestine, Texas (vertical cutoff rigidity=4.5GV), yielding an exposure factor of 20 m^2 sr h. The measured mean neutron excess, <A> -2Z, of the source elements C, Ne, Mg, and Si is 0.05 +- 0.03, 0.45 +- 0.10, 0.32 +- 0.11, and 0.26 +- 0.16, respectively, at the top of the atmosphere, normalized to a value for O of 0.06. The mean neutron excess for Ne, Mg, and Si at the source implied by these results is calculated taking into account the effects of galactic propagation. Although the errors are large, it is found to agree for all these elements with solar system isotopic composition. The mean neutron excess for nitrogen (the ^{15}N fraction) is 0.45 +- 0.07 at the top of the atmosphere consistent with an origin for nitrogen principally by spallation in the interstellar medium. The amount of nitrogen required in the cosmic-ray source relative to carbon is 0.07 +- 0.02.

1586 **Relativistic Be^7: A probe of cosmic-ray acceleration.** Buffington, A.; Orth, C.D.; Mast, T.S. (Space Sciences Laboratory and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **41**: No. 8, 594-597(21 Aug 1978).

We have observed the cosmic-ray Be^7/Be ratio to be 0.6 below 500 MeV/nucleon, as expected from spallation reactions, but then to drop sharply to 0.4 by 1500 MeV/nucleon. This measurement suggests that primary cosmic rays traverse some material at their sources, producing Be^7 which picks up electrons and decays by K capture during or after the acceleration to relativistic energies. All cosmic rays then enter interstellar space, where further pickup is negligible.

1587 Energy balance of cosmic rays in multiple scattering in a randomly inhomogeneous magnetic field. Dorman, L.I.; Kats, M.E.; Fedorov, Y.I.; Shakhov, B.A. (Geophysics Institute, Ukrainian Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 6, 353-356(20 Mar 1978).

The equation for the energy density of cosmic rays is used to analyze the variation of their energy following multiple scattering by random magnetic-field inhomogeneities that move with velocity u(r). It is shown that if the radial gradient of the cosmic rays is positive the particles land in the acceleration regime.

STARS

REFER ALSO TO CITATION(S) 1582

1588 (LA-UR—78-1511) Theoretical mean colors for RR Lyrae variables. Davis, C.G.; Cox, A.N. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 16p. (CONF-780690—1). Dep. NTIS, PC A02/MF A01.

From Conference on current problems in stellar pulsation instabilities; Greenbelt, MD, USA (1 Jun 1978).

A hydrodynamically pulsating 0.6 M/sub solar/ model of a typical RR Lyrae variable was studied with a radiation transport-hydrodynamic computer program to predict theoretical T/sub e/ and colors at many phases and to find the proper methods for getting mean colors and the consequent mean effective temperatures. The variable Eddington radiation approximation method was used with gray and with multifrequency absorption coefficients to represent the radiation flow in the outer optically thin layers. Comparison between observed and computed B-V colors indicates that these low Z Population II models are reasonably accurate using King 1A composition opacities. The well known Oke, Giver, and Searle relation between B-V and T/sub e/ is reproduced. Mean colors are found by four different averaging methods. The method that gives a mean color and the mean T/sub e/ closest to the nonpulsating model was the separate intensity means of B and V, just as the case for previous studies of classical Cepheids. The best mean for T/sub e/, which is known for all pulsation phases from four color observations of real RR Lyrae variables or from the calculated model, is a time average of T/sub e/ without any weighting function.

1589 Fragmentation of isothermal rings and star formation. Norman, M.L.; Wilson, J.R. (Department of Applied Science, University of California, Davis; and Lawrence Livermore Laboratory, University of California, Livermore). *Astrophys. J.;* **224**: No. 2, 497-511(1 Sep 1978).

Numerical studies of the collapse of a rotating interstellar cloud predict the formation of a ring of matter embedded in the infalling gas cloud. The assumption of axisymmetry in those calculations most likely limits their range of validity to the early stages of collapse before nonaxisymmetric perturbations become important. In this paper we present the results of calculations on the stability of an isothermal ring to nonaxisymmetric perturbations by numerically integrating the equations of hydrodynamics in three space dimensions.We find that the ring fragments primarily into two or three bodies in less than one-half of a rotation period of the ring. The implication for the observational fact that most stars occur in multiple systems is clear. We find the mass and specific angular momentum for each of the resulting bodies to be roughly 10% of those quantities of the initial gas cloud. A "cascading" process in star formation is discussed where each of the resulting bodies would form rings in its collapse, which would fragment, etc.

1590 Triple-mode cepheid masses. Cox, A.N.; King, D.S.; Hodson, S.W. (Los Alamos Scientific Laboratory, University of California). *Astrophys. J.;* **224**: No. 2, 607-613(1 Sep 1978).

Observations of the light variations of AC Andromedae and TU Cassiopeiae are reviewed. The radial fundamental, first overtone, second overtone, and three nonlinear coupling beat pulsation periods of AC And are presented, confirming the Fitch and Sxeidl work. For TU Cas the radial fundamental, first overtone, and several nonlinear coupling beat periods can be found, and a Fourier analysis has confirmed Faulkner's result at 1.25 days; the small amplitude of this third periodicity, however, makes it reality uncertain. Using an inhomogeneous model with helium enrichment (Y=0.48) in the surface convection zones and mixed downward to the 300,000 K level or 5 x 10^{-4} of the mass, the three periods give a mass for AC And as 3 M/sub sun/. This is consistent with an evolutionary first crossing of the Cepheid instability strip. TU Cas has periods that indicate a mass of 4 M/sub sun/ using a similar model but normal composition (Y=d0.356,Z=0.044) at the surface and enriched between 80,000 and 150,000 K (2 x 10^{-4} of the mass) to Y=0.70. A first or second crossing is possible; but if the enrichment is by a Cepheid wind and downward mixing, there is more time for TU Cas on the second crossing. If the second overtone of TU Cas does not exist, the variable does not need the thin normal helium composition surface layer and is just another double-mode Cepheid with Y~0.5 down to the 200,000 K level.

1591 Effects of rotation and convection on double-mode and bump cepheids. Deupree, R.G. (Los Alamos Scientific Laboratory, University of California). *Astrophys. J.;* **223**: No. 3, 982-985(1 Aug 1978).

The effect of solid-body rotation on the period ratio P_{i_1}/P_{i_0} is studied with a two-dimensional, nonlinear, adiabatic hydrodynamics code in an effort to reduce or remove the discrepancies found between evolutionary masses for Cepheids and the masses determined by application of the Pirho/sup 1/2/ relation to the two modes of double-mode Cepheids. The changes in period ratio found are far too small to reconcile the masses determined from pulsation theory with those of evolution theory.The application of the period ratio P_{i_2}/P_{i_0} to the bump Cepheids is based on the stimulated second overtone result of Simon and Schmidt; however, this was derived only for radiative models. We therefore applied our time-dependent convection-pulsation hydrodynamics code to a bump Cepheid model to examine the effects of convection on the existence of a bump. While there is evidence that such effects are present, convection cannot remove the mass discrepancy.

1592 Implications of fission mass distributions for the astrophysical r-process. Steinberg, E.P.; Wilkins, B.D. (Chemistry Division, Argonne National Laboratory). *Astrophys. J.;* **223**: No. 3, 1000-1014(1 Aug 1978).

The role of nuclear fission in the astrophysical r-process is examined, and calculated fission fragment mass distributions are utilized to interpret observed elemental abundance data. A number of features of the solar system abundance curve are accounted for. An extension of the r-process to neutron numbers near 200 is required to provide a fission-source explanation of the rare-earth abundance peak. An r-process path that crosses the 184-neutron shell at A=276 (about 4 Z-units lower than presently accepted) is suggested to account for the rare-earth abundances and the high ratio of masses 136 to 148. The "xenon anomaly" is discussed within the general context of the treatment, and a superheavy fission precursor is shown to be unlikely. Correlations of abundance anomalies in Ap stars are pointed out, and the anomalies are classified according to cycle time.

1593 Hydrodynamics of primordial black hole formation. Nadezhin, D.K.; Novikov, I.D.; Polnarev, A.G. (Institute of Applied Mathematics, Academy of Sciences of the USSR, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 129-138(Mar 1978).

The hydrodynamic behavior of primordial black hole (PBH) formation early in the expansion of the universe is examined, assuming that near the singularity the expansion was quasi-isotropic. The nonlinear, spherically symmetric problem of the development of initially strong perturbations relative to a Friedmann background model is solved numerically. The type of perturbations required for PBHs to form is ascertained. The role of pressure gradients is evaluated in detail. At the time of its formation a PBH will have a mass considerably smaller than the mass within the cosmological horizon; hence a catastrophic accretion process appears unlikely.

1594 Cosmological implications of the process of primordial black hole evaporation. Vainer, B.V.; Nasel'skii, P.D. (Rostov University). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 138-140(Mar 1978).

Limits are set on the density distribution of primordial black holes with M<10^{15} g. Assuming that initial density perturbations existed in a standard cosmological model, constraints are placed on the amplitude of the fluctuations.

1595 Thermal instabilities in a nonstationary medium. Shchekinov, Y.A. (Rostov University). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 182-186(Mar 1978).

The problem of thermal instabilities under nonstationary conditions is considered [temperature T=T (t), generalized loss function L not =0]. Instability criteria are derived for perturbations of various wavelengths. The temperature range admitting thermal instability of short-wave perturbations is wider in a cooling (L>0) than in a heated (L<0) or a stationary (L=0) medium. In most cases, long-wave perturbations will dissipate during the thermal evolution time of the system, even if they are initially growing. Thermal instability is discussed as a possible mechanism of star formation.

1596 Photometric classification and observed characteristics of type II supernovae. Pskovskii, Y.P. (P. K. Shternberg State Astronomical Institute). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 201-205(Mar 1978).

The relationships between the elements of the light curves, color curves, and expansion velocities of type II supernova shells and their photometric classes introduced by the author are discussed.

1597 Thermal emission of an optically thick plasma containing a strong magnetic field. Pavlov, G.G.; Shibanov, Y.A. (A. F. Ioffe Physicotechnical Institute). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 214-222(Mar 1978).

The intensity and polarization spectra and the directional diagrams are found for the emission of a photosphere having a strong (ω/sub H/> or $\approx\omega$, hω/sub H/> or $\approx$kT) magnetic field, in which free—free transitions predominate. A number of observational effects which result from the presence of a magnetic field in the photosphere are discussed: cyclotron resonances in the spectra; narrowing of the directional diagram, the magnitude of which depends nonmonotonically on the frequency; a change in the sign of the circular polarization and a jump in the position angle of the linear polarization at some frequencies, etc. The results of the work are applied to the interpretation of observations of hot magnetic white dwarfs. Many qualitative effects can also be observed in the emission of a wider class of objects having strong magnetic fields. In particular, the dependence of the width of the directional diagram on the energy of a quantum which is found can be manifested in the emission of x-ray pulsars. It is noted that the linear polarization of the emission of a number of white dwarfs can be explained without drawing on the hypothesis that very strong magnetic fields are present in their coronas.

1598 Close binaries and the evolution of star clusters. Dokuchaev, V.I.; Ozernoi, L.M. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 15-20(Jan 1978).

The formation of "tight" pairs within a star cluster (that is, binary stars whose binding energy exceeds the mean kinetic energy of the cluster members) may significantly affect the evolution of the cluster. If the number of tight pairs has become comparable to the total star population during the final stages of the secular contraction of the cluster core (after about 40 relaxation times), then energy exchange between these pairs and the remainder of the cluster would be capable of converting the contraction of the core to an expansion. The requisite number of pairs would be produced in a populous system not by triple but by double encounters of stars, accompanied by tidal effects. The new evolutionary features a stellar system would acquire through the influence of tight pairs upon it imply that collapse of the cluster core and the formation of a massive central black hole can be averted. Numerical calculations will be needed to specify the conditions whereby this situation may arise. Applications to globular clusters and the galactic nucleus are discussed.

1599 Hydrodynamics of collisionless spherical stellar systems in a steady state. Osipkov, L.P. (Leningrad University). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 23-26(Jan 1978).

The applicability of hydrodynamic equations of arbitrary order to the dynamics of stellar systems is discussed. Analysis of the system of moment equations for steady-state spherical systems demonstrates that excess in the velocity distribution will be absent if and only if the velocity dispersions satisfy the standard relations of ellipsoidal dynamics.

1600 Integrated circular polarization of spectral lines due to inhomogeneous magnetic and velocity fields. Pavlov, G.G.; Shibanov, Y.A. (Ioffe Physics and Technology Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 43-46(Jan 1978).

Analytic expressions are obtained for the integrated circular polarization of spectral lines in the solar or a stellar atmosphere. Such polarization, which would result from inhomogeneities in the magnetic field and in the macroscopic velocity field of mass motion, is determined as a function of the gradients in these fields and of the line strength, for selected absorption coefficient profiles.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

1601 Radio spectrum of the compact source at the galactic center. Brown, R.L.; Lo, K.Y.; Johnston, K.J. (National Radio Astronomy Observatory, Green Bank, West Virginia 24944). *Astron. J.;* **83**: No. 12, 1594-1597(Dec 1978).

Observations of the compact radio source at the Galactic center obtained at 11.1 and 3.7 cm with the Green Bank 35-km radiolink interferometer and at 6, 2, and 1.3 cm with the VLA reveal that the flux density of the source increases with increasing frequency for $\nu <$ or $\approx$25 GHz. This result, taken in conjunction with recent VLBI observations which show Sgr-A to be $<$ or $\approx$0".001 (10 AU), requires either that the magnetic field in the source is very high, B>200 G, or that the true source size is significantly smaller than the VLBI limits, $\theta <$ or $\approx$2 AU, and hence that the energy density in the source is very large, >15 erg cm^{-3}. An alternative to this description is provided by the similarity of the radio properties of Sgr-A to those of Galactic radio stars in which the opacity at centimeter wavelengths is provided by free—free absorption. If this latter interpretation is applicable, the compact radio source at the Galactic center is likely associated with one member of a multiple-star system.

1602 Nature of the quasisteady component of the centimeter radiation of variable radio sources. Kuril'chik, V.N. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 169-172(Mar 1978).

The quasisteady radio emission of variable extragalactic radio sources observed at centimeter wavelengths can be explained by a model with a quasisteady outflow of relativistic electrons from the nucleus of the object into an outer steady magnetic field tube. The tube would be located at the magnetic pole of the nucleus and would expand with radial distance. Calculations yield a spectrum of the form F/sub ν/∞/sub ν/(5/2)-3(γ+4)/2(γ+1) $\infty\nu$/sup -0.3/ for an inhomogeneous radio source of this kind, with some additional peculiarities that depend on the orientation of the object in space. The model results are compared with observational data.

1603 Multiple scattering pf pulsar signals by turbulent interstellar plasma. Bugnolo, D.S. *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 38-42(Jan 1978).

The stochastic transport theory originally developed by the author for the study of electromagnetic wave propagation in media characterized by a random-phase velocity is applied to the problem of the propagation of a pulsar signal through the turbulent interstellar plasma. The theoretical results are used to predict the amplitude fluctuations of pulsar radiation and the coherence of pulsar signals in the frequency domain. A comparison is made with a few experimental data. The mean scale of the turbulence is estimated. Analysis of this kind can not only elucidate the effects of the interstellar medium on pulsar characteristics but it can aid us in understanding the medium itself. Future extensions of the theory could be applied to improve the design of large-scale radio astronomy systems using adaptive receivers in searches for encoded signals generated by extraterrestrial civilizations.

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 1630

1604 (BNL—24674) **Results of the ^{37}Cl experiment.** Davis, R. Jr. (Brookhaven National Lab., Upton, NY (USA)). [nd]. Contract EY-76-C-02-0016. 56p. (CONF-780117—2). Dep. NTIS, PC A04/MF A01.

From Solar neutrino conference; Upton, NY, USA (5 Jan 1978).

Present results of the ^{37}Cl experiment to measure the flux of ^{8}B neutrinos from the sun are presented. The results are plotted, and the technical details are discussed. From a ^{37}Ar production rate above the background of 0.30, the possible solar neutrino rate was deduced to be 5.31 x (0.30 +- 0.08) = 1.6 +- 0.4 SNU. (JFP)

1605 Mechanism of generation of solar radio bursts of the "drifting pairs" type. Zaitsev, V.V.; Levin, B.N. (Radiophysics Institute, Gor'kii). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 223-227(Mar 1978).

A mechanism is proposed for the generation of drifting pairs on the basis of the cyclotron excitation of plasma waves by a stream of fast particles in regions of double plasma resonance, with the subsequent transformation of the excited waves into electromagnetic waves as a result of combination scattering. The main characteristics of double bursts are explained on the basis of this mechanism.

1606 Intensity ratio of second and third harmonics in type III solar radio bursts. Zlotnik, E.Y. (Gor'kii Radiophysics Institute). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 228-230(Mar 1978).

It is shown that the ratio of the intensities of the third and second harmonics can be considerably greater than that predicted in [V. V. Zheleznyakov and E. Ya. Zlotnik, Solar Phys. 36, 451 (1974)] if the angular spectrum of the plasma waves excited by the electron stream, which are responsible for the generation of type III bursts, has a quasi-one-dimensional character. Numerical estimates are presented for the event of February 28, 1973, described by Takakura and Yousef [T. Takakura and S. Yousef, Solar Phys. 36, 451 (1974)].

1607 Theoretical spectrum of the free oscillations of the sun. Vorontsov, S.V.; Zharkov, V.N. (Institute of Earth Physics, Academy of Sciences of the USSR, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 46-52(Jan 1978).

The spectrum of quadrupole oscillations of polytropic models for the internal structure of the sun is calculated, and the customary scheme for classifying oscillations by p, f, and g modes is discussed. With the oscillations of a standard solar model as an illustration, it is shown that such a classification may cause misunderstanding when observed periods are identified with a theoretical normal-mode spectrum. An auxiliary classification for oscillations of the outer layers is proposed.

1608 Three-dimensional structure of the interplanetary magnetic field. Korzhov, N.P. (Siberian Institute of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Siberian Branch of the Academy of Sciences of the USSR). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 53-59(Jan 1978).

An analysis of white-light observations of the corona on the OSO-7 satellite indicates the existence of distinctive coronal ribbon structures, which can be observed at the limb as coronal streamers. It is shown that the continuation of these structures into interplanetary space forms a curved surface, the crossing of which is accompanied by a change in the polarity of the interplanetary magnetic field (IMF). The observed sectoral structure of the interplanetary field is the result of intersection of this three-dimensional pattern with the ecliptic plane. The large-scale three-dimensional structure of the IMF which existed during May—July 1973 is found and its connection with certain phenomena in the solar atmosphere is revealed.

GALAXIES

REFER ALSO TO CITATION(S) 1582

1609 Shock waves in the intergalactic medium at large red shifts. Ozernoi, L.M.; Chernomordik, V.V. (Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 141-147(Mar 1978).

An analysis is made of shock waves generated in the intergalactic medium by young galaxies, quasars, and active galaxy nuclei at red shifts $z<$ or ≈ 10—30. The propagation of the shocks is considered with allowance for the cosmological expansion, as well as their radiative energy losses and their influence on the intergalactic gas. Because of the radiation losses of the shock waves, hot rarefied cavities may develop in the intergalactic medium, surrounded by cool, dense walls. When shock waves emanating from individual sources cross one another, the intergalactic gas (if its density is not too low) will take on a cavern-type structure with interpenetrating chambers and walls.

1610 Scattering in an inhomogeneous reflection nebula. Voshchinnikov, N.V. (Leningrad University). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 188-191(Mar 1978).

A spherical model nebula with a deficiency of small-sized particles in regions adjoining the central star is considered. Scattering functions have been calculated from the Mie theory, assuming single scattering, for spherical grains of silicates and impure ice. For an inhomogeneous nebula there can be a substantial drop in the percentage polarization, especially in the red wavelength range.

COSMOLOGY

1611 Formation and evolution of clumps of galaxies in an expanding universe. Norman, C.A.; Silk, J. (Huygens Laboroary, Leiden). *Astrophys. J.;* **224**: No. 2, 293-301(1 Sep 1978).

We derive results for the development of phase-space clumps of mass points in a background spectrum of gravitational potential fluctuations. The Vlasov equation and the pair correlation equation (in the weak coupling limit) are solved exactly in an Einstein—de Sitter cosmology, and the plasma clumping theory is used to identify terms that yield important collective effects. Various astrophysical implications are discussed, including the formation of large-scale inhomogeneity and the enhanced generation of correlations in the distribution of galaxies.

1612 Some astrophysical consequences of the existence of a heavy stable neutral lepton. Gunn, J.E.; Lee, B.W.; Lerche, I.; Schramm, D.N.; Steigman, G. (California Institute of Technology; and Institute of Astronomy, Cambridge, England). *Astrophys. J.;* **223**: No. 3, 1015-1031(1 Aug 1978).

Recently, high-energy particle theorists have constructed new extended gauge theories which may fit experiment somewhat better than previous already very successful theories. One of the predictions which is often discussed is the possible existence of a stable neutral lepton, probably with a mass of a few GeV/c^2. Following this motivation we here investigate some cosmological consequences of the existence of any stable, massive, neutral lepton, and show that it could well dominate the present mass density in the universe. The contribution to the mass density depends on the mass of the lepton, which should eventually be determined with high-energy accelerators. It is interesting that the more massive the lepton, the smaller its contribution to the present mass density. It is unlikely that these leptons affect big bang nucleosynthesis or condense into stellar size objects. However, such a lepton is an excellent candidate for the material in galactic halos and for the mass required to bind the great clusters of galaxies. Annihilation radiation from these structures should be detectable. At the end of the paper a brief mention is made of the astrophysical constraints on the mass-lifetime relationship if the neutral lepton is unstable.

1613 Optimal quantum measurements in detectors of gravitation radiation. Braginskii, V.B.; Vorontsov, Y.I.; Khalili, F.Y. (Moscow State University). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 276-280(5 Mar 1978).

When continuous measurement is made with an instrument whose interaction with the gravitational antenna has a Hamiltonian proportional to the instantaneous coordinate, the sensitivity of the detector has in principle a limit. It becomes necessary to use a procedure with a pulsed measurement of the coordinate.

1614 Long-wavelength perturbations of a Friedmann universe, and anisotropy of the microwave background radiation. Grishchuk, L.P.; Zel'dovich, Y.B. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 2, 125-129(Mar 1978).

Observational evidence, which is necessarily confined to a region of the universe limited in space (within the observer's horizon), implies a high degree of homogeneity and isotropy for the large-scale structure of the universe. In principle, substantial deviations of the properties of the real universe from the parameters of an idealized Friedmann cosmological model could have prevailed on scales exceeding that of the horizon. Constraints on the amplitude of perturbations with such long wavelengths are imposed by the virtual isotropy ($\delta T/T < 10^{-4}$) of the observed background radiation. This information on $\delta T/T$ together with the natural hypothesis that the perturbations are statistically independent implies that on spatial scales exceeding the horizon there exist no significant (with amplitude of order greater than $\delta T/T$) perturbations in density. For certain types of perturbations in the metric (in the gravitational field), the amplitude could be appreciable without contradicting the empirical limits on $\delta T/T$.

1615 Synthesis of light elements in a big-bang model universe. Vainer, B.V.; Dryzhakova, O.V.; Zaguskin, V.L.; Marochnik, L.S.; Reznitskii, L.I. (Rostov University). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 1-6(Jan 1978).

Calculations of the thermonuclear synthesis of light elements in a big-bang model universe are reported. A new method is described for solving the equations of nuclear reaction kinetics; it affords quite high accuracy and saves considerable machine time. The results of R. V. Wagoner's calculations are confirmed. It is further shown that large-amplitude temperature and entropy fluctuations will enhance the deuterium abundance by two or three orders of magnitude, so that the observed abundance will be approached even if matter has nearly the critical density. In addition, entropy fluctuations will increase the He^4 abundance by 3%—6%.

1616 Opportunities for detecting ultralong gravitational waves. Sazhin, M.V. (Shternberg Astronomical Institute, Moscow). *Sov. Astron. AJ (Engl. Transl.);* **22**: No. 1, 36-38(Jan 1978).

The influence of ultralong gravitational waves on the propagation of electromagnetic pulses is examined. Conditions are set forth whereby it might be possible to detect gravitational waves arriving from binary stars. There are some prospects for detecting gravitational radiation from double superstars with masses $M_1 \approx M_2 \approx 10^{10}$ M/sub sun/.

1617 Quantum gravitational effects in an anisotropic universe. Vereshkov, G.M.; Grishkan, Y.S.; Ivanov, S.V.; Nesterenko, V.A.; Poltavtsev, A.N. (Rostov State University). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1041-1051(Dec 1977).

A study is made of the effects of vacuum polarization, particle creation, and interaction of particles with a self-consistent gravitational field in an anisotropic Bianchi type I universe. An asymptotic expansion is obtained for the propagator of scalar particles which makes it possible to classify quantum effects. The radiative corrections are calculated in the logarithmic approximation and the energy-momentum tensor of real particles is calculated under the assumption of local thermodynamic equilibrium. All results are presented in covariant form. Einstein's equations are written down with allowance for those quantum gravitational effects. These equations are then used to analyze the cosmological evolution of an anisotropic universe. It is found that the quantum gravitational effects change the nature of the cosmological singularity in such a way that the divergences of all physical quantities at the singular point are entirely due to conformal factors. The effect of the particle production is to isotropize the expanding universe at Planck times irrespective of the initial conditions specified during the contraction stage. A certain relationship is established between the parameters that characterize the geometry and the matter in an expanding universe.

PLANETARY PHENOMENA

1618 (LA-UR—78-1358) **Petrology of a sequence of pyroclastic rocks from the Taurus-Littrow (Apollo 17 landing site).** Heiken, G.; McKay, D.S. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 27p. (CONF-780314—5). Dep. NTIS, PC A03/MF A01.

From 9. lunar science conference; Houston, TX, USA (Mar 1978).

We have studied 13 samples from core 740012 using petrographic methods and electron probe microanalysis. The samples represent most of the major units described in the core by Nagle (1978). Below 5.5 cm, the samples consist entirely of whole and broken orange glass droplets and the partly to completely crystallized black equivalents. We believe these droplets are pyroclastic ejecta from a lunar volcano. The crystalline droplets contain olivine and ilmenite as major phases. Minor phases include pyroxene, Cr-spinels, and metallic Fe. Four different properties of these droplets suggest that a wide range of cooling rates are represented. These properties are the grain shapes, the degree of crystallization, the olivine shapes or textures, and the olivine compositions. Many droplets contain vesicles indicating that a gas phase was involved in the eruption. Above 5.5 cm the core sequence has undergone in situ reworking by micrometeorites and contains "exotic" fragments including basalt and agglutinates. We conclude that the sequence below 5.5 cm represents 3.5 b.y. old volcanic pyroclastic ejecta which was deposited in a relativley short time period, was buried, and was subsequently brought to the lunar surface by the Shorty Crater impact where it was subjected to minor in situ reworking.

1619 (PNL-SA—6570) **Use of outer planet satellites and asteroids as sources of raw materials for life support systems.** Molton, P.M.; Divine, T.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1977. Contract EY-76-C-06-1830. 41p. (CONF-7710155—1). Dep. NTIS, MF A01.

From Space industrialization conference; San Francisco, CA, USA (17 Oct 1977).

Portions of document are illegible.

Industrialization of space and other space activities depend entirely on supply of materials from the Earth. This is a high cost route for materials supply. Space industrialization will require life support systems for maintenance and operation staff and these will of necessity be of a sophisticated nature. Use of raw materials obtained by an unmanned space shuttle, initially, and by manned shuttles later could significantly reduce the cost of life support in space. These raw materials could be obtained from small asteroids and satellites, and would consist of primary nutrients. Future development of such sources is discussed, including food production in automated asteroid-based facilities. The level of technology required is available now, and should become economical within a century.

1620 Comet West 1976 VI: Discrete bursts of dust, split nucleus, flare-ups, and particle evaporation. Sekanina, Z.; Farrell, J.A. (Harvard—Smithsonian Center for Astrophysics, Cambridge, Massachusetts 02138). *Astron. J.;* **83**: No. 12, 1675-1680(Dec 1978).

Analysis of four small-scale photographs of Comet West taken on 5—8 March 1976 offers evidence of five discrete bursts of dust from the comet's nucleus between 19 and 28 February, i.e., from six days before perihelion to three days after it. The images of the comet on the photographs were computer-enhanced to increase the contrast of the fine structure. The timing of two of the bursts suggests very strongly that they accompanied the two breakup events that gave birth to the companion nuclei D and B. The primary breakup, on 19 February, also coincides with a 2-magnitude surge in the comet's brightness. Some of the other dust bursts might be correlated with less conspicous flare-ups observed in both the visual brightness and the thermal emission of the comet. A distinct intensity discontinuity makes up the trailing boundary of the main body of the dust tail. When the observed position of the discontinuity is corrected for an effect of particle-expulsion velocity, it is found to correspond to dust expelled from the comet exactly at perihelion. It is suggested that because of its timing, the intensity discontinuity could be a product of particle evaporation sharply peaked at perihelion.

1621 Is osmium chemically fractionated in the moon: a response. Jovanovic, S.; Reed, G.W. Jr. (Argonne National Lab., IL). *Geochim. Cosmochim. Acta, Suppl.;* 53-56(1977).

Evidence is presented based on replicate experiments on highland breccias to support attributing variations in Os contents to sampling. Some aliquants yielded Os contents of 20 ppB or greater. Concentrations at this level are considered "excessive" by the authors. Ru and Ir appear to be more coherent than Os and Ir. For the latter a cosmic ratio of approximately 1 and another ratio of approximately 3 are observed to be about equally populated with lithic breccias. The Ir relationships do not appear to alter our proposal that Ru and Os were chemically fractionated in the moon.

1622 Trace element geochemistry and the early lunar differentiation. Jovanovic, S.; Reed, G.W. Jr. (Argonne National Lab., IL). *Geochim. Cosmochim. Acta, Suppl.;* 623-632(1977).

Discrete Cl—P_2O_5 groupings of lunar samples have been noted and the suggestion made that distinct residual liquids were the sources of the groups (Jovanovic and Reed, 1976a). It was proposed that each Cl—P_2O_5 group was associated with an early lunar magma-ocean convection cell in which anorthositic and mafic phases differentiated. A laterally inhomogeneous crust resulted. In this report we suggest that the few samples that do not have the signature of the region in which they were collected are exotic--i.e., originated in a remote region. Since major and minor element concentrations are not expected to vary greatly from cell to cell, the mineralogy and petrology of samples may be relatively insensitive to the cell in which they evolved. This could pose a problem in genetically relating samples found at a given site. Ru and Os have been fractionated from one another and also partitioned in the stratigraphic column resulting from the differentiation of the early lunar magma ocean. Lithic breccias contain two types of fractionated Ru—Os which appear to be related to near-surface crustal stratigraphy. Basalts contain fractionated Ru—Os which is correlated with their depths of origin based on the ages of extrusion which are related to the depths at which melting occurred. Correlation of Ru/Os elemental ratios with initial Sr isotopic ratios relates Ru and Os to the early lunar differentiation.

ATMOSPHERIC PHYSICS

1623 Effect of multiple scattering on species concentrations and model sensitivity. Luther, F.M.; Wuebbles, D.J.; Duewer, W.H.; Chang, J.S. (Lawrence Livermore Laboratory, University of California Livermore, California 94550). *J. Geophys. Res.;* **83**: No. C7, 3563-3570(20 Jul 1978).

Multiple scattering significantly affects atmospheric photodissociation rates, particularly at wavelengths greater than 290 nm. Incorporating the effects of multiple scattering into a one-dimensional transport-kinetics model led to dramatic changes in the concentration profiles of many trace species: thus it is important to include multiple scattering when model results are compared with observational data. The effect on model sensitivity of including multiple scattering ranged from no change in ΔO_3 compared with the pure absorption calculation to significant increase in ΔO_3 depending upon the model chemistry. The change in ΔO_3 due to multiple scattering was small in comparison with the change in ΔO_3 resulting from the varying chemical reaction rates. Variations in surface albedo had little effect on model sensitivity.

AURORAL AND IONOSPHERIC PHENOMENA

1624 (AD-A—051122) **Large-scale optical mapping of the ionosphere. Environmental research papers.** Weber, E.J.; Lloyd, J.W.F.; Buchau, J.; Eather, R.H. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)). 21 Oct 1977. 31p. (AFGL-TR—77-0236; AFGL-ERP—611). NTIS PC A03/MF A01.

A new instrument for all sky, spectrophotometric imaging of aurora and airglow was installed in the Air Force Geophysics Laboratory's Airborne Ionospheric Observatory. Initial observations of equatorial and near-equatorial 6300 angstroms O I airglow show the existence of north-south aligned regions of airglow depletion. These dark bands often extend more than 1200 km in the north-south direction and 50 to 200 km in the east-west direction. Simultaneous airborne ionospheric soundings indicate that these regions of airglow depletion are characterized by an increase in the virtual height of the F-layer. A simple model of field-aligned electron density depletion in the bottomside of the F-layer explains both the airglow observations and the ionospheric soundings. Initial auroral zone measurements show the structure and dynamics of the subvisual auroras in the noon sector that result from dayside precipitation. UHF satellite-to-aircraft propagation through the F-region auroras result in amplitude scintillations, both in the noon and midnight local time sectors. (Author)

1625 (AD-A—051134) **Analysis of the Faraday rotation differential absorption technique for D-region measurements.** Baker, K.D.; Harris, R.D.; McCue, R.A.; Westlund, C.D. (Utah State Univ., Logan (USA). Space Science Lab.). Aug 1977. Contract F19628-74-C-0130. 94p. (SCIENTIFIC—4). NTIS PC A05/MF A01.

This report describes the optimization of a radio propagation experiment suitable for studies of the ionosphere D-region utilizing relatively low power, portable ground-based transmitters and simple receivers aboard small sounding rockets. A wave propagation model has been developed that numerically calculates the radio signal that would be received by a dipole antenna aboard a rocket traveling up through the ionospheric D-region. The Faraday rotation and differential absorption experienced by the wave can be used to deduce both electron concentrations and electron-neutral collision rates in the D-region. Faraday rotation and differential absorption were numerically calculated for a number of radio frequencies for three types of extreme conditions such as occur at high magnetic latitudes. Altitude profiles of these quantities provide information to base a selection of 2 or 3 frequencies that will yield maximum information on electron density and collision rate, based on the expected ionospheric conditions. Signal limitations such as atmospheric noise, te-

lemetry error and transmission power were also used to interpret the Faraday rotation and differential absorption curves in order to achieve maximum accuracy.

1626 Recent progress in studies of DMSP auroral photographs. Akasofu, S.I. (Univ. of Alaska, Fairbanks). *Space Sci. Rev.;* **19**: 169-215(1976).

A new auroral pattern, which indicates major auroral characteristics in all local time sectors, is presented. It has emerged as a result of extensive study of DMSP-8531 and -10533 auroral photographs. The paper presents also a brief summary of recent studies on the role of the north—south component of the interplanetary magnetic field on large-scale auroral dynamics and on the relationship between substorm energy and the size of the oval.

MAGNETOSPHERIC PHENOMENA

1627 (AD-A—051418) **Thermal structure of the topside ionosphere observed by INJUN 5 during an intense magnetic storm. Environmental research papers.** Burke, W.J.; Sagalyn, R.C. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)). 28 Nov 1977. 28p. (AFGL-TR—77-0261; AFGL-ERP—614). NTIS PC A03/MF A01.

Electron densities and temperatures as well as omnidirectional fluxes of hyperthermal positive ions ($E > 28$ eV) were measured by means of spherical Langmuir probes aboard INJUN 5 at altitudes > 2000 km during a major geomagnetic storm. The electron density in the mid-latitude trough decreased and the temperatures increased during the early phases of the storm. As the storm progressed, the position of the trough moved equatorward, with plasma depletions being observed to an invariant latitude of 40 deg during the early recovery phase. The latitude of the transition between heavy- and light-ion dominance also moved equatorward, but recovered at a rate slower than that of the position of the electron trough. Hyperthermal ions detected in the vicinity of the trough were ring current particles reaching to the satellite's altitude. The minimum thermal electron densities in the trough were found to be within 1 deg of latitude of the maximum ring current flux. Maximum electron temperatures were measured several degrees equatorward of this position. INJUN 5 electron temperatures are compared with those measured by Alouette 2 over the reported positions of SAR arcs. The observations are also used to evaluate further a method developed for calculating the position of the ring current by use of ground magnetic fluctuations.

1628 (AD-A—051419) **Thermal and hyperthermal electron distributions in the midnight sector of the winter topside ionosphere. Environmental research papers.** Burke, W.J.; Sagalyn, R.C.; Kanal, M. (Air Force Geophysics Lab., Hanscom AFB, MA (USA)). 28 Nov 1977. 28p. (AFGL-TR—77-0262; AFGL-ERP—615). NTIS PC A03/MF A01.

A gridded spherical electrostatic analyzer aboard Injun 5 has been used to measure fluxes of thermal and hyperthermal electrons at sub-auroral latitude in the midnight sector of the northern ionosphere between altitudes of 2500 and 850 km. Due to the offset between the geomagnetic and geographic poles, hyperthermal fluxes consisting of energetic photoelectrons that have escaped from the sunlit southern hemisphere are observed along orbits over the Atlantic Ocean and North America but not over Asia. The ambient electron temperatures near 2500 km have their highest values at trough latitudes for all longitudes. On the basis of these observations it is concluded that, at trough latitudes, elevated electron temperatures in the topside ionosphere are produced by sources other than conjugate photoelectrons; Equatorward of the trough in the Atlantic Ocean, North American longitude sector conjugate photoelectrons contribute significantly to the heating of electrons in the topside ionosphere. Much of the photoelectron energy is deposited at altitudes greater than 2500 km, then conducted along magnetic field lines into the ionosphere.

1629 (EGG—1183-5085) **Skylab-barium alpha and beta L = 6 field-line tracing experiments.** Eastman, T.E.; Wright, D. (EG and G, Inc., Los Alamos, NM (USA)). Jun 1978. Contract EY-76-C-08-1183. 39p. Dep. NTIS, PC A03/MF A01.

Events SKYLAB-BARIUM ALPHA (27 November 1973) and BETA (4 December 1973) were shaped-charge barium field-line tracing experiments near L approximately equal to 6, conducted jointly by the Los Alamos Scientific Laboratory and the University of Alaska Geophysical Institute. Image-orthicon and pulsed intensified auroral cameras provided data for triangulating the fast ion streaks. Using the POGO 10-68, epoch 1965.0, field-line model with Mead-Fairfield corrections for the outer field, the triangulated positions of the fast ion streak were projected down to the 100 km altitude northern conjugate surface. The projected positions moved toward magnetic east with a velocity of 725 m/sec for both SKYLAB-BARIUM ALPHA and BETA. Assuming only an E x B/B^2 force, this drift velocity is consistent with an electric field toward magnetic south of 39 mV/m. Radiometric analysis of the filtered, intensified auroral camera records gave observed peak radiance values of about 2×10^{-11} watts/cm^2-Sr in the 455.4 nm line of Ba^+. The barium in the portion of the ion streak for which radiometric data were obtained had initial injection velocities of 9.5 to 13.5 km/sec in both events. This portion of the ion streak for both SKYLAB-BARIUM ALPHA and BETA contained approximately 4×10^{23} ions compared to the 6.4×10^{24} atoms contained in the barium liner. Ion inventory estimates are based on a solution of the statistical equilibrium equations. Corrections have been made in the ion inventory calculations for Doppler shifts of the solar spectrum as received in the rest frame of the high-velocity barium ions.

1630 (LA-UR—78-1640) **Characteristics of the magnetospheric boundary layer and magnetopause layer in high time resolution.** Eastman, T.E.; Hones, E.W. Jr. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 12p. (CONF-780598—1). Dep. NTIS, MF A01.

From Symposium on solar-terrestrial physics; Innstruck, Austria (29 May 1978).

Portions of document are illegible.

A basic problem of magnetospheric physics is to determine how and where solar wind mass, momentum and energy is transferred to the magnetosphere. IMP 6 plasma and magnetic field data indicate that the closed magnetospheric boundary layer is always present adjacent to and earthward of the magnetopause layer at all locations equatorward of the entry layer and plasma mantle. All IMP 6 crossings show some magnetosheath-like plasma earthward of the magnetopause layer and the boundary layer electron spectra are often indistinguishable from the nearby magnetosheath electron spectra. In 24 out of 40 crossings, no change in density or electron spectra is observed near the magnetopause layer. In most remaining cases, changes in the plasma parameters occur primarily in the boundary layer. Observed boundary layer bulk plasma flow always has an anti-sunward component and often has a cross-field component. Energetic electron pitch angle distributions indicate that the boundary layer is on closed field lines. During six IMP 6 crossings near local noon, equatorward of the cusp regions, boundary layer plasma flow was observed to have an anti-sunward component consistent with flow away from the subsolar region or the nearby magnetosheath. The observations are not consistent with a primary source in the cusp region or any other nonlocal source. It is concluded that the boundary layer is populated primarily by direct plasma transport through the magnetopause layer.

1631 Three-satellite measurements and field-line mapping of the outer plasma sheet boundary from r~1.2 to ~18R/sub E/ during substorms. Pytte, T.; Lundlbad, J.A.; Soeraas, F.; Hones, E.W. Jr.; West, H.I. Jr. (Department of Physics, University of Bergen, N-5014 Bergen, Norway). *Geophys. Res. Lett.;* **5**: No. 7, 585-588(Jul 1978).

Simultaneous and near-conjugate observations of energetic particles in the outer region of the plasma sheet by three satellites (Esro 1A, Ogo 5, and Vela 5B) shoe clear indications of a close relationship between the instantaneous latitudinal location of the high-latitude precipitation boundary at 1000 to 1500 km height and the thickness of the plasma sheet at geocentric distances of 10 to 18 R/sub E/. By comparing low-altitude and magnetotail particle energy spectra and by using recent magnetospheric field-line models as spatial reference systems, we find evidence that the precipitation boundary and the outer plasma sheet boundary are magnetically connected. The correlation between plasma sheet recovery and a poleward expansion of the precipitation boundary from A~70° to ~75° late in substorms suggests that this recovery is associated with rapid magnetic field-line reconnection as the reconnection region apparently moves to a more distant location in the tail.

1632 Magnetotellurics using lock-in signal detection. Goubau, W.M.; Gamble, T.D.; Clarke, J. (Department of Physics, University of California, and Materials and Molecular Research and Earth Sciences Divisions, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Geophys. Res. Lett.;* **5**: No. 6, 543-546(Jun 1978).

Magnetotelluric measurements were performed simultaneously at two sites 4.8 km apart near Hollister, California. The data obtained at each site were analyzed using the two magnetic field measurements at the other site as a remote reference. Even for data for which the E-E predicted coherencies were as low as 0.1, the apparent resistivities obtained using this technique were consistent with resistivities calculated from high coherency data at adjacent periods. Apparent resistivities calculated by a conventional analysis of the same data were biased downward by magnetic noise, sometimes by as much as two orders of magnitude.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

1633 Improved resolution in fixed-wavelength photoelectron—photoion coincidence spectroscopy. Eland, J.H.D. (Argonne National

Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **49**: No. 12, 1688-1690(Dec 1978).

The paper describes a technique of extraction-field pulsing, whereby the energy resolution in fixed-wavelength photoelectron—photoion coincidence spectroscopy can be substantially improved and extended light sources can be used.

1634 Low-energy electron diffraction study of the surface of thin crystals and monolayers of normal paraffins and cyclohexane on the Ag(111) crystal surface. Firment, L.E.; Somorjai, G.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **69**: No. 9, 3940-3952(1 Nov 1978).

The surfaces of the normal paraffins (C_4—C_8) and cyclohexane in the form of thin single crystal films (10^2 A) condensed upon an Ag(111) single crystal surface have been studied using low-energy electron diffraction (LEED). The physical adsorption of monolayers of these molecules was also studied on the Ag(111) surface. The data were compared with similar data obtained from experiments on the Pt(111) surface (Ref. 1) to yield the following results : n-Octane condenses on either substrate with its unreconstructed (101) plane parallel to the substrate. Cyclohexane similarly condenses exposing its (001). n-Heptane multilayers on either substrate give the same LEED pattern, but the surface unit mesh is different from any of the expected planes of the n-heptane crystal structure. n-Hexane and n-pentane multilayers form pseudomorphic crystal structures, that are dependent upon the structure of the substrate. Physically adsorbed monolayers of n-octane, n-heptane, and n-hexane adsorb in ordered structures with their molecular axes parallel to each other and the Ag<110>. Cyclohexane adsorbs in a (9 x 9) structure in a hexagonal array with its molecular plane parallel to the Ag(111) surface. The generally lower temperatures necessary to order monolayers on Ag(111) indicate that unsaturated hydrocarbons are less strongly adsorbed on this surface than on the Pt(111).

1635 Deuterium magnetic resonance of some polymorphic liquid crystals: The conformation of the aliphatic end chains. Hsi, S.; Zimmermann, H.; Luz, Z. (Department of Chemistry, Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California Berkeley, California 94720). *J. Chem. Phys.;* **69**: No. 9, 4126-4146(1 Nov 1978).

Deuterium magnetic resonance measurements of four members of the homologous series p-alkoxybenzylidene-p-alkylaniline (noxm), perdeuterated in their alkoxy chains, are reported. The compounds studied were 40x7, 50x7, 60x7, and 70x7. For 50x7 various isotopic species specifically deuterated in the alkoxy chains, as well as in the benzylidine moiety, were prepared and their DMR studied. These measurements allowed a complete assignment of the resonances from the alkoxy chain. The spectrum of all four compounds was studied over their whole mesomorphic regions. In most phases well resolved spectra were obtained yielding the various quadrupole splittings and in many cases also the dipolar interactions within the methylene and methyl groups. Using double quantum spectroscopy dipolar splitting between different methylene deuterons could also be resolved. The methylene quadrupolar splittings and the dipolar interaction within the methylene groups decrease along the chain towards the methyl end in a characteristic stepwise manner. This behavior is attributed to chain reorientational freedom and is quantitatively interpreted in terms of two structural factors: (i) Fast dynamical equilibrium between the all-trans conformation of the alkoxy chains and chain conformations involving one or more kinks, and (ii) a molecular model in which the aliphatic chain axis is inclined with respect to the molecular long axis. The characteristic pattern of the splitting can then be reproduced by assuming a monotonically increasing kink probabilities along the chain towards its methyl end. This interpretation is used to estimate the kink probability distribution in the alkoxy chains in the various compounds and mesophases. No significant effect of the mesophase structure on the kink statistics was found.

1636 High temperature Raman band contours and vibrational analysis of arsenic oxide vapors. Rytter, E.; Goates, S.K.; Papatheodorou, G.N. (Institutt for Uorganisk Kjemi, Universitetet i Trondheim, N-7034 Trondheim-NTH, Norway). *J. Chem. Phys.;* **69**: No. 8, 3717-3722(15 Oct 1978).

Raman spectra of vapors over arsenic oxide have been obtained at temperature up to 1200 K. Three Raman bands not reported previously have been observed and vibrational—rotational contours for E and F species fundamentals of As_4O_6 have been resolved. A band of medium intensity at 410 cm^{-1} was found to be polarized and its relatively high intensity was attributed to Fermi resonance between the $2\nu_6$ and the ν_2 modes. A valence force field calculation has been carried out, and the mean amplitudes of vibration and Cartesian displacements of As_4O_6 have been evaluated. The vibrations have been compared with AsO_3 fundamentals by a group theoretical correlation method.

1637 Cyanide stretching vibrations in 1-D tetracyanoplatinate conductors. Ferraro, J.R.; Basile, L.J.; Williams, J.M.; McOmber, J.; Shriver, D.F.; Greig, D.R. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **69**: No. 8, 3871-3874(15 Oct 1978).

The Raman spectra and infrared spectru of 1-D tetracyoursplatinate conductors is discussed.(AIP)

1638 Photoionization of CH_3OH, CD_3OH, and CH_3OD: Dissociative ionization mechanisms and ionic structures. Berkowitz, J. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **69**: No. 7, 3044-3054(1 Oct 1978).

The molecules CH_3OH, CD_3OH, and CH_3OD have been investigated by photoionization mass spectrometry from the onset of dissociative ionization to 20 eV. The process forming methyl ion and hydroxyl radical is shown to be direct, rather than statistical. Near threshold, the process involving molecular hydrogen elimination is shown to lead to the structure $HCOH^+$, rather than H_2CO^+. Removal of an H atom leads predominantly to CH_2OH^+, although some evidence exists for a CH_3O^+ structure at higher energy. Similarly, the structure HCO^+ is seen to be much more prevalent than COH^+, but the latter may be formed with increasing probability at higher energy. Some astrophysical implications regarding the formation of CH_2O in dense interstellar clouds are discussed.

1639 Molecular beam photoionization study of acetone and acetone-d_6. Trott, W.M.; Blais, N.C.; Walters, E.A. (Department of Chemistry, University of New Mexico, Albuquerque, New Mexico 87131). *J. Chem. Phys.;* **69**: No. 7, 3150-3158(1 Oct 1978).

High resolution photoionization efficiency curves have been obtained for $CH_3COCH_3^+$ and $CD_3COCD_3^+$ using supersonic molecular beam sampling. As a result of adiabatic cooling during the nozzle expansion, sufficient concentrations of $(CH_3COCH_3)_2$, $(CD_3COCD_3)_2$, $(CH_3COCH_3)_3$, and $(CH_3COCH_3)_4$ were formed to permit the study of their photoion yield curves as well. Appearance potential curves have been determined for CH_3CO^+, CD_3CO^+, and $(CH_3COCH_3)\ xCH_3CO^+$ fragments. The measured ionization potentials of acetone and acetone-d_6 monomers are 9.694 +- 0.006 and 9.695 +- 0.006 eV, respectively. Transitions to higher vibrational levels in $CH_3COCH_3^+$ are seen at 320, 695, and 930-1370 cm^{-1} above threshold. The effect of perdeutero substitution is to reduce these frequencies to 260 and 660—1100 cm^{-1}. Appearance potentials of CH_3CO^+ and CD_3CO^+ fragments are observed at 10.52 +- 0.02 and 10.56 +- 0.02 eV, respectively. The measured ionization energies for (CH_3COCH_3)/sub n/, n=1—4, are found to decrease linearly as a function of 1/n. Observed ionization thresholds for $(CH_3COCH_3)_2$, $(CH_3COCH_3)_3$, and $(CH_3COCH_3)_4$ are 9.26 +- 0.03, 9.10 +- 0.03, and 9.02 +- 0.03 eV, respectively. Within experimental resolution, the ionization potentials of $(CH_3COCH_3)_2$ and $(CD_3COCD_3)_2$ are identical. The appearance potential of the process $(CH_3COCH_3)_2 \rightarrow (CH_3COCH_3)\ xCH_3CO^+ + CH_3 + e^-$ is found to be 10.08 +- 0.05 eV. By consideration of appropriate thermodynamic cycles, a lower bound for the acetone dimer ion binding energy is calculated to be 0.538 eV (12.4 kcal/mole) and the desolvation energy of $(CH_3COCH_3)\ xCH_3CO^+$ is estimated to be 0.544 eV (12.5 kcal/mole).

1640 X-ray and neutron diffraction study of liquid antimony trichloride at 80°C. Triolo, R.; Narten, A.H. (Chemistry Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **69**: No. 7, 3159-3162(1 Oct 1978).

X-ray and neutron diffraction experiments with liquid $SbCl_3$ at 80°C are described and discussed. The liquid consists of discrete molecules with an Sb—Cl distance of 2.35 A and a Cl—Sb—Cl angle of 96°. The diffraction data are analyzed to yield structure functions for intermolecular atom pair interactions. The radial distribution functions obtained from these curves yield directly some valuable insight into the nature of the strong spatial correlations present in liquid $SbCl_3$.

1641 Intermolecular potential energy surfaces from electron gas methods .III. Angle, distance, and vibrational dependence of the Ar—CO interaction. Parker, G.A.; Pack, R.T. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **69**: No. 7, 3268-3278(1 Oct 1978).

Angle, distance, and vibrational coordinate dependent Ar—CO intermolecular potentials, suitable for studies of rotationally and vibrationally inelastic Ar—CO collisions, are presented. The short range repulsive interaction is calculated using the electron gas model and tested against accurate ab initio SCF results at a few points; agreement is very good. Semiempirical van der Waals coefficients C_6 through C_8 for the long range attractive interaction of CO with He, Ne, Ar, Kr, and Xe are also determined. The resulting long and short range potentials are joined together in two different ways to give complete potentials which are smooth and reasonable everywhere and give second virial coefficients in excellent agreement with experiment.

1642 Condon internal diffraction in the O/sub u/$^+$ → O/sub g/$^+$ fluorescence of photoassociated Hg_2. Ehrlich, D.J.; Osgood, R.M. Jr. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). *Phys. Rev. Lett.;* **41**: No. 8, 547-550(21 Aug 1978).

We have observed a well-resolved Condon diffraction pattern in the O/sub u/$^+$ ($v \simeq 57$) → O/sub g/$^+$ (unbound) fluorescence of Hg_2. The upper state is excited by photoassociating mercury atoms with an ArF laser at 193 nm.

1643 Transition probabilities for the resonance transitions of Na-like ions. Kim, Y.; Cheng, K. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Opt. Soc. Am.;* **68**: No. 6, 836-842(Jun 1978).

Theoretical wavelengths and transition probabilities for the 3S—3P and 3S—4P transitions of Na-like ions are presented. The theoretical data are computed from relativistic Hartree-Fock wave functions. Similar data for additional transitions between low-lying states (n = 3 and 4) of the Fe^{15+}, Mo^{31+}, W^{63+}, and Au^{69+} ions are also reported. Relativistic effects in the oscillator strengths for the resonance transitions are qualitatively similar to those already observed in the Li sequence. Comparison with available experimental data on wavelengths for Fe^{15+} and Mo^{31+} ions shows excellent agreement (1% or better).

1644 Equations-of-motion method for F_2: transition energies, oscillator strengths and born cross sections. Rescigno, T.N. (Univ. of California, Livermore); Bender, C.F.; McKoy, B.V. *Chem. Phys. Lett.;* **45**: No. 2, 307-310(15 Jan 1977).

The equations-of-motion method has been used to study various electronic states of F_2. The transition energies have been found in both the random phase approximation (RPA) and higher random approximation (HRPA) using single particle—hole components in the excitation operators. We have also computed generalized oscillator strengths (Born cross sections) for the scattering of high energy electrons by F_2.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 1662

1645 Gas discharge ion source III. Modified Berkeley multifilament ion source. Bickes, R.W. Jr.; Bacon, F.M.; O'Hagan, J.B. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Rev. Sci. Instrum.;* **49**: No. 11, 1513-1517(Nov 1978).

Total ion current, ion energy, mass and current density distributions, and the impurity content of the ion beams produced by a modified Berkeley multifilament ion source (MFIS) were measured as a function of source configuration, gas pressure, and operating conditions: the "best" configuration produced beams of 200 mA or more at pressures between 0.40 and 2.0 Pa. In comparison with earlier studies of duoplasmatron and duopigatron sources, the MFIS beams contained less D^+, only ca. 33%, but the beams had much narrower energy distributions and flatter current density distributions. The beams contained 1%—2% impurities which consisted mainly of masses 18, 20, and 22.

1646 Z, velocity, and target-material dependence of convoy electrons from solids. Laubert, R.; Sellin, I.A.; Vane, C.R.; Suter, M.; Elston, S.B.; Alton, G.D.; Thoe, R.S. (New York University, New York, New York 10003). *Phys. Rev. Lett.;* **41**: No. 10, 712-715(4 Sep 1978).

We test the conjecture that convoy electrons emitted from solid targets originate from electrons bound in the potential wake trailing the traversing ion. Although we observe distinct differences in the longitudinal velocity distribution between solid and gaseous targets, we do not observe the predicted Z_1, velocity, and target-material dependences. From the this we conclude that the majority of convoy electrons from solids do not originate from wake-bound electrons.

1647 Method of obtaining polarized protons by laser radiation. Letokhov, V.S.; Lobashev, V.M.; Minogin, V.G.; Mishin, V.I. (Spectroscopy Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 284-287(5 Mar 1978).

A method is proposed for obtaining a high-intensity beam of polarized protons, capable of 100% polarization in beams with angular aperture up to 10°. The method is based on optical quenching, selective in the projections of the total angular momentum, of the hydrogen atom from the metastable 2S state and subsequent photoionization of the atoms with definite projection of the angular momentum via the Rydberg state.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 1063

1648 Hyperfine structure of excited, odd-parity levels in ^{139}La by laser—atomic-beam fluorescence. Childs, W.J.; Goodman, L.S. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Opt. Soc. Am.;* **68**: No. 10, 1348-1350(Oct 1978).

Dipole and quadrupole hyperfine structure constants are reported for a number of excited, odd-parity levels of ^{139}La. The results were obtained by analysis of the fluorescence induced from a lanthanum atomic beam by a single-frequency dye laser beam.

1649 16-μm generation by CO_2-pumped rotational Raman scattering in H_2. Byer, R.L.; Trutna, W.R. (Edward L.,Ginzton Laboratory of Physics, Stanford University, Stanford, California 94305). *Opt. Lett.;* **3**: No. 4, 144-146(Oct 1978).

We have generated 50 mJ of 16.9-μm radiation by stimulated rotational Raman scattering in 3 atm of H_2 gas pumped by a CO_2 TEA-laser source. Threshold was reached by injection of a few microjoules of 16.9-μm radiation generated by four-wave mixing. We achieved 25% peak power, or 40% peak photon conversion efficiency.

1650 Associative ionization of laser-excited Rydberg states in strontium vapor. Worden, E.F.; Paisner, J.A.; Conway, J.G. (Lawrence Livermore Laboratory, Livermore, California 94550). *Opt. Lett.;* **3**: No. 4, 156-158(Oct 1978).

Using mass spectrometry we have confirmed that Sr_2^+ ions are produced from laser-populated Rydberg states by the associative ionization process $Sr(5snl)+Sr(5s^2) \rightarrow Sr_2^+ + e^-$. Dimer ion signal was detected for the $5s6d\,^3D_2$ level, indicating that the binding energy of Sr_2^+ exceeds 0.77 eV. We have observed that under certain conditions the Rydberg states are destroyed by electron-impact ionization before an associative ionization collision can occur.

1651 Improved Pauli Hamiltonian for local-potential problems. Wood, J.H.; Boring, A.M. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., B;* **18**: No. 6, 2701-2711(15 Sep 1978).

A recently published scheme for obtaining an approximate solution of the Dirac-Hartree-Fock equations for an atom is adapted and applied to the related Dirac-Slater problem. For a given nl, one solves explicitly only for one large component orbital instead of the four determined in the Dirac-Slater calculations. The equation for this single component is closely akin to the Pauli equation. (We find that the Pauli mass-velocity and Darwin operators are accurate to only zeroth (instead of first) order in $(E-V)/c^2$. We present forms which are accurate to first order for cases in which the expansion in $(E-V)/c^2$ is valid.) Atomic calculations for uranium and plutonium demonstrate that this approximate method yields eigenvalues, eigenfunctions, spin-orbit parameters, and excitation energies in close agreement with the Dirac-Slater results. The method can be incorporated into existing nonrelativistic molecular and energy-band computer programs (such as those for the molecular scattered-wave method and the KKR and APW energy-band methods). This would then permit nearly relativistic solutions of the related problems without the complications introduced by the four-component-type solutions. We discuss implementation of the method for the scattered wave and APW methods.

1652 Absolute oscillator strengths for neutral atomic uranium. Bieniewski, T.M. (Los Alamos Scientific Laboratory of the University of California, Los Alamos, New Mexico 87545). *J. Opt. Soc. Am.;* **68**: No. 9, 1173-1181(Sep 1978).

The furnace absorption method has been applied to the spectrum of neutral atomic uranium. In the wavelength interval, 355.2 > or = λ (nm) > or = 359.4, the absolute oscillator strengths for 57 transitions in neutral uranium have been determined. For the strongest transition at 358.487 74 nm, the result was f (358.4) = 0.041 +- 0.003. This latter result is in excellent agreement with the absolute oscillator strength derived from three separate lifetime measurements and the calculated branching ratio for the 591.538 74 nm transition.

1653 Lifetime, branching ratio, and absolute transition probability of the 6395.42 A transition of ^{238}U I. Hackel, L.A.; Rushford, M.C. (Lawrence Livermore Laboratory, P.O. Box 808, Livermore, California 94550). *J. Opt. Soc. Am.;* **68**: No. 8, 1084-1087(Aug 1978).

We have refined and extended an existing technique for determining an atomic transition probability by carefully measuring the transition branching ratio (BR) and excited-state lifetime (tau), with particular attention paid to systematic errors. The technique was applied to the red region of the ^{238}U I spectrum where little accurate data is presently available. In particular, we find for the 6395.42 A transition the following values: tau = 607 +- 20 ns, BR = 0.586 +- 0.05, and $g_2A = 1.45 \times 10^7$ +- 1.25×10^6.

1654 Lasing at λ=97.2 nm[1]) in hydrogen. Troshin, B.I.; Chebotaev, V.P.; Chernenko, A.A. (Institute of Semiconductor Physics, USSR Academy of Sciences, Siberian Division). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 273-276(5 Mar 1978).

Lasing was produced at the wavelength $\lambda = 97.2$ nm in monatomic hydrogen near the 4P—1S transition by resonant mixing of two second-harmonic photons and one fundamental-frequency photon of a pulsed dye laser.

1655 Parity nonconservation effects in two-photon transitions in hydrogen atoms. Drukarev, E.G.; Moskalev, A.N. (B. P. Konstantinov Leningrad Nuclear Physics Institute). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1078-1081(Dec 1977).

Parity nonconservation effects in two-photon transitions 1s/sub() 1/2/→2p/sub() 1/2/ and 2s/sub() 1/2/→2p/sub() 3/2/ in a hydrogen atom arising if the neutral weak currents do not is 10^{-6}—10^{-9}. However, in the case of absorption of photons with equal energies and parallel or antiparallel momenta in the transition 1s/sub() 1/2/→2p/sub() 1/2/ the magnitude of these effects increases and attains values of 10^{-4}—10^{-6}.

1656 Coherence transfer in metastability exchange in the mixture of the isotopes He^3 and He^4. Zhitnikov, R.A.; Kartoshkin, V.A.; Klement'ev, G.V. (A. F. Ioffe Physicotechnical Institute, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 912-916(Nov 1977).

We consider coherence transfer in the exchange of metastability in a mixture of He^3 and He^4. It is shown that this process results in appreciable shifts of the magnetic-resonance frequency in the 2 $^3S_1$ states of the He^3 and He^4 atoms. The appearance of these shifts, which has been predicted theoretically, is confirmed by experiments on the optical orientation and magnetic resonance of 2 $^3S_1$-metastable helium atoms. The dependences of these shifts on the temperature, pressure, and concentration of the helium isotopes in the He^3—He^4 mixture are determined.

1657 Technique for relativistic spin-polarised calculations. Koelling, D.D. (Argonne National Lab., IL); Harmon, B.N. *J. Phys., C (London);* **10**: 3107-3114(1977).

Band structure calculations for the magnetic rare earth metals are complicated by both the necessity of including relativistic effects, and the desire to keep spin as a good quantum number for describing the Russell-Saunders-like 4f-shell and the exchange polarization of the conduction electrons. We present a technique for the reduction of the Dirac equation which initially omits the spin—orbit interaction (thus keeping spin as a good quantum number), but retains all other relativistic kinematic effects such as mass-velocity, Darwin, and higher order terms. The technique is easily adopted using existing non-relativistic band structure programs. Coupled first-order differential equations are solved which do not involve derivatives of the potential. The spin—orbit interaction can be included as a perturbation once the "relativistic" spin-polarized bands and wavefunctions have been obtained. The technique is used together with the local spin density approximation for exchange and correlation to calculate the self-consistent charge and spin density of a neutral Gd atom. The calculated magnetic form factor agrees extremely well with experiment. Comparison with a paramagnetic RAPW calculation shows the procedure should be both accurate and fast for general band structure determinations.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

1658 Observation of "slow" negative-muon spin relaxation in oxides. Evseev, V.S.; Mamedov, T.N.; Roganov, V.S.; Frontas'eva, M.V. (Joint Institute for Nuclear Research). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 233-235(5 Mar 1978).

Observation is reported of a decrease, with time, of the asymmetry of the angular distribution of the muon-decay electrons in the mesic atoms of oxygen in oxides.

1659 Existence of a quadrupole moment in muonium. Baryshevskii, V.G.; Kuten', S.A. (Belorussian State University). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1063-1065(Dec 1977).

It is shown that even in its ground-state, muonium (hydrogen, mu-nucleonic atom) has a quadrupole moment which is comparable in magnitude to nuclear quadrupole moments. This leads to a pronounced effect of inhomogeneous intracrystalline fields on the spin precession and relaxation of μ^+ mesons and may serve as a basis for carrying out experiments with muonium (mu-nucleonic atoms) which are analogous to quadrupole resonance and relaxation.

1660 Study of the angular correlation of photons in annihilation of orthopositronium. Antuf'ev, Y.P.; Zabolotnyi, V.D.; Popov, A.I.; Storizhko, V.E. (Physico-Technical Institute, Ukrainian Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1069-1070(Dec 1977).

An apparatus has been constructed for measurement of the angular correlation and energy spectrum of photons in the three-photon annihilation of positronium. Use of a finely ground powder of magnesium oxide placed in vacuum to stop the positrons permitted a three-photon annihilation probability of 20% to be obtained. The measured angular correlation and energy spectrum of the photons are in agreement with a quantum electrodynamics calculation within the statistical accuracy of the experiment, which amounts to 5%.

1661 Theory of the temperature dependence of the muon precession frequency shift for anisotropic muonium. Ivanter, I.G. *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 861-863(Nov 1977).

Equations have been obtained for the polarization density matrix for muonium for the case of anisotropic hyperfine interaction which may occur in impurity hydrogen (and muonium) in strongly doped semiconductors. Expressions have been obtained for the precession of muionium in a transverse field and it has been shown that the anisotropic characteristics of the hyperfine interaction can be obtained from the variation of the temperature dependence of the amplitudes and the frequencies of muon precession.

COLLISION PHENOMENA

1662 (COO—4644-1) Production of electronically-excited species by photoselection of pathways (POP). (Toronto Univ., Ontario (Canada)). [nd]. Contract ED-78-C-02-4644. 7p. Dep. NTIS, PC A02/MF A01.

An apparatus in which four beams intersect at one point in a high vacuum chamber is described, characterizing each of the four beams. First results are presented giving evidence concerning the reactive cross section dependence on collision energy for the reaction H + Br_2→ HBr + Br. It is planned to refine these results and look for the effect of a high intensity laser field on this or related reactions. 6 references. (JFP)

1663 (LA-UR—78-1948) R-matrix methods. Robb, W.D. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 21p. (CONF-780687—1). Dep. NTIS, PC A02/MF A01.

From Mathematical and computational aspects of scattering theory meeting; Ontario, Canada (Jun 1978).

The procedures used in the application of R-matrix theory to atomic and molecular collision processes are presented. The computationally advantageous features of these methods are high-lighted, and some applications to electron scattering and photoionization are briefly discussed.

1664 Electron-impact excitation of low-lying electronic states in CS_2, OCS, and SO_2. Flicker, W.M.; Mosher, O.A.; Kuppermann, A. (Arthur Amos Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125). *J. Chem. Phys.;* **69**: No. 9, 3910-3916(1 Nov 1978).

Variable angle, electron-impact energy-loss spectra of CS_2, OCS, and SO_2 have been obtained at incident electron energies of 25, 40, and 70 eV for CS_2, and 30 and 55 eV for OCS and SO_2. Singlet→triplet excitations are observed with peaks at transition energies of 3.36 eV in CS_2, 4.94 eV in OCS, and 3.40 eV in SO_2. A feature which peaks at 3.65 eV in CS_2 is observed to have singlet→triplet character. The CS_2 and OCS spectra do not confirm the existence of several spin-forbidden transitions reported in solid phase ultraviolet absorption studies of these molecules. In SO_2, no evidence is found of transitions to the 1 $^3A_2$ and 1 $^3B_2$ states, believed to lie near the well-known a $^3B_1$ state.

1665 Inelastic scattering of alkali halides by rare gases. McGinnis, R.P.; Greene, E.F. (Metcalf Chemical Laboratories, Brown University, Providence, Rhode Island 02912). *J. Chem. Phys.;* **69**: No. 9, 4073-4075(1 Nov 1978).

Measurements from three laboratories of the inelastic scattering of alkali halides by rare gases are consistent with the formation of a short-lived complex. The results from transfer of large or small amounts of translational energy to or from the internal modes can be fitted by calculations based on a simple statistical model.

1666 Classical path approximation in time-dependent quantum collision theory. Augustin, S.D.; Rabitz, H. (Chemistry Department, Princeton University, Princeton, New Jersey 08540). *J. Chem. Phys.;* **69**: No. 9, 4195-4200(1 Nov 1978).

Time-dependent treatments of molecular collisions have frequently employed the combination of quantum equations for the internal degrees of freedom (i.e., vibration, rotation) with a classical description of the translational motion. In this paper, it is shown how energy-conserving classical path equations may be derived from first principles, thereby obtaining quantum correction terms of arbitrary order. These expressions have interesting implications for the question of how the classical limit is approached. If the translational degree of freedom is assumed to be described by a very narrow wave packet, the correction term to first order in $\hbar$ is purely imaginary and therefore non-Hermitian. These techniques can be generalized to a classical treatment of other degrees of freedom, and the case of rotation in an atom—vibrotor collision is explicitly considered. For both the translational and rotational examples, the full series of corrections takes on an interesting and suggestive

exponential form. The failure of classical path methods to satisfy microscopic reversibility is ascribed to a difficulty with the boundary conditions for the translational motion.

1667 Velocity dependence of angular distributions in gas/solid—surface collisions: Relationship to the interaction potential. Brady, J.W. Jr.; Doll, J.D.; Thompson, D.L. (Univeristy of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **69**: No. 8, 3458-3461(15 Oct 1978).

The angular and velocity distributions for gas/solid-surface collisions are examined. It is shown that the envelope of the scattered phase-space distribution is quite sensitive to the gas/surface interaction potential.

1668 R-matrix solution of coupled equations for inelastic scattering. Stechel, E.B.; Walker, R.B.; Light, J.C. (The James Franck Institute and Department of Chemistry, The University of Chicago, Chicago, Illinois 60637). *J. Chem. Phys.;* **69**: No. 8, 3518-3531(15 Oct 1978).

The R-matrix propagation method for solving the close coupled equations for inelastic scattering is presented. The method is shown to be fast, accurate, and stable without the need for stabilizing transformations. We demonstrate the use of this method for two model close coupling problems, and investigate the rate of convergence of the solutions.

1669 Electronic spectroscopy of 1,3,5,7-cyclooctatetraene by low-energy, variable-angle electron impact. Frueholz, R.P.; Kuppermann, A. (Arthur A. Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125). *J. Chem. Phys.;* **69**: No. 8, 3614-3621(15 Oct 1978).

The electron-impact energy loss spectrum of 1,3,5,7-cyclooctatetraene has been measured at electron impact energies of 30, 50, and 75 eV, and scattering angles varying from 5° to 80°. Three transitions with maxima at 3.05, 4.05, and 4.84 eV are identified as singlet → triplet excitations. The significance of the lowest lying of these triplet states in the quenching process of dye laser solutions (in particular rhodamine 6G) is discussed and an exciplex mechanism for triplet quenching is suggested. Singlet→singlet transitions are observed at 4.43, 6.02, and 6.42 eV. These spin-allowed transitions have been observed optically and are assigned as X $^1A_1 \rightarrow {}^1A_2$, X $^1A_1 \rightarrow {}^1E$, and X $^1A_1 \rightarrow {}^1E$ excitations. Three new, singlet → singlet transitions are observed at 6.99, 8.41, and 9.05 eV and are tentatively assigned as the X $^1A_1 \rightarrow {}^1B_2$, X $^1A_1 \rightarrow {}^1E$, and X $^1A_1 \rightarrow {}^1E$, $\pi \rightarrow \pi^*$ excitations. Several superexcited features between 10 and 15 eV have been observed and are believed to involve excitations to autoionizing Rydberg states.

1670 Classical inelastic scattering in $Li+H_2$: A comparison of different potential energy surfaces. Wagner, A.F.; Wahl, A.C.; Karo, A.M.; Krejci, R. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **69**: No. 8, 3756-3774(15 Oct 1978).

Four different ab initio calculations were used to determine four sets of potential energies at a common set of geometries for the $Li+H_2$ collision system. The four calculations involved choices between a moderate and a large basis set and between the Hartree—Fock and the multiconfiguration-self-consistent field formalisms. Only the nonreactive ground electronic state surface was examined. An analytic functional form was least squares fit to each set of potential energies to produce four analytic potential energy surfaces. Classical trajectories at energies below the reaction threshold were run on each surface. The trajectories were analyzed to obtain the inelastic cross sections, differential cross sections, and average energy loss as a function of angle. The comparison of these collision observables from surface to surface was used to characterize the chemical accuracy of each surface. All four surfaces, from the least to the most accurate, produced significant amounts of rotational excitation.

1671 Low-energy electron interactions with organic molecules: Negative ion states of fluorobenzenes. Frazier, J.R.; Christophorou, L.G.; Carter, J.G.; Schweinler, H.C. (Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **69**: No. 8, 3807-3818(15 Oct 1978).

An electron transmission technique has been employed to determine the positions of the three π-negative ion states (configurations $\pi_1{}^2\pi^2{}_2\pi^2{}_3\pi_4{}^1$, $\pi^2{}_1\pi^2{}_2\pi^2{}_3\pi^1{}_5$, and $\pi^2{}_1\pi_2{}^2\pi^2{}_3\pi^1{}_6$) of benzene and fluorobenzenes in the vapor phase. These are 1.13 (1.35), 1.13 (1.35), (4.80) eV for benzene; 0.82 (0.91), (1.40), (4.66) eV for fluorobenzene; 0.53 (0.62), (1.41), (4.51) eV for p-difluorobenzene; (0.77), (0.77), (4.48) eV for 1,3,5-trifluorobenzene; 0.34, (0.50), (1.29), (4.51) eV for 2,3,5,6-tetrafluorobenzene; <0.15 (0.36), (1.19), (4.53) eV for pentafluorobenzene; and (0.42), (0.42), (4.50) eV for hexafluorobenzene. The numbers in parentheses are the vertical attachment energies, and those not in parentheses are the 0→0 transitions. On the basis of these data, the first π-electron affinities (E.A.) of the isolated molecules of these compounds are equal to -1.13, -0.82, -0.53, >-0.77, -0.34, > or =-0.15, >-0.42 eV for benzene, fluorobenzene, difluorobenzene, 1,3,5-trifluorobenzene, 2,3,5,6-tetrafluorobenzene, pentafluorobenzene, and hexafluorobenzene, respectively. The present results, therefore, suggest that the π-electron affinity of C_6F_6 is <0.0 eV, although C_6F_6 is known to have a positive (+1.8 eV) E.A. and although the parent ion, $C_6F_6{}^-$*, is known to form with a very large electron attachment cross section at ~0.0 eV and to be long lived (~12 μsec). These findings are reconciled, discussed in connection with previously published data, and are theoretically treated. They extend our understanding of the negative ion states of substituted benzenes.

1672 Electron transfer in collisions between atomic ions and rare-gas atoms for primary-ion energies below 200 eV. II. Maier, W.B. II. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *J. Chem. Phys.;* **69**: No. 7, 3077-3092(1 Oct 1978).

Cross sections have been measured for electron transfer from rare-gas atoms to H^+, He^+, Ne^+, Ar^+, and Kr^+, for reactant kinetic energies E_0 in the center-of-mass between 0.4—120 eV, and for ground-state reactants. These cross sections appear to have thresholds. The magnitudes of the cross sections and the apparent threshold energies depend systematically on the identities of the primary ion and target atoms. These reactions appear to leave the products in excited states. The secondary ions normally pick up considerable momentum from the primary ion and are produced with a distrubition in their kinetic energy. Interesting structure is found in the cross section for $Kr^+ + Ar \rightarrow Ar^+ + xxx$. At low E_0, excited primary ions are found to yield very different cross sections than unexcited primary ions. It is suggested herein that an adequate theoretical description of these findings may require fairly accurate potential energy curves for the reactant and product systems.

1673 Electron-impact spectroscopy of the alkynes: A comparison of propyne and 1-butyne with acetylene. Flicker, W.M.; Mosher, O.A.; Kuppermann, A. (Arthur Amos Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California 91125). *J. Chem. Phys.;* **69**: No. 7, 3311-3320(1 Oct 1978).

The electronic excitation spectra of propyne and 1-butyne have been investigated by the method of variable angle electron-impact spectroscopy. In both molecules, two singlet→triplet transitions were observed with maximum intensities at 5.2 and 5.8$_5$ eV. No evidence was found for the existence of any transitions with vertical excitation energy below 5 eV. A number of previously unreported transitions to superexcited states in both propyne and 1-butyne were detected. The relationship of these spectra to those of acetylene is discussed, and the different behavior of valence and Rydberg transition energies in response to alkyl substitution is explained qualitatively in terms of the different excited state charge distributions.

1674 Si K-shell ionization and electron transfer cross sections: Solid targets. Tawara, H.; Richard, P.; Gray, T.J.; Newcomb, J.; Jamison, K.A.; Schmiedekamp, C.; Hall, J.M. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., A;* **18**: No. 4, 1373-1380(Oct 1978).

The Si K x-ray production cross sections for F/sup q/+(q = 3—9) ion impact in the energy range of 0.4—2.2 MeV/amu are determined in the limit of a vanishingly thin target from the observed target thickness dependence of the x-ray yields. The ionization cross sections are deduced from the measured x-ray production cross sections using an average fluorescence yield (omega-tilde = $1.5\omega_0$, where ω_0 is the fluorescence yield for an atom with single K vacancy) determined from high-resolution x-ray spectra and configuration fluorescence yields. For F/sup q/+ (q < or = 6) ion impact, the measured ionization cross sections are compared with the plane-wave-Born-approximation prediction with and without the Coulomb deflection and increased-binding-energy effects. The Si K shell to F K shell electron-transfer cross sections are determined from the difference between the ionization cross sections for F^{9+} ions and those for F/sup q/+ ions (q < or = 6). The results are compared with the prediction based on the two-state atomic-expansion method and that based on the modified Oppenheimer-Brinkman-Kramers approximation. A comparison is also made between the Si solid-target measurements with those obtained for gaseous Ne and Ar gas targets. The solid-target and gas-target data are consistent at 1.58 MeV/amu. Finally, from a comparison between the measured equilibrium x-ray yields and the calculated x-ray yields using the equilibrium charge distribution of projectiles after passing through foils, it is found that the projectiles have a considerably larger number of K-shell vacancies inside solids than after passing through solids at lower-impact energies.

1675 Radiative lifetimes and oscillator strengths for allowed intra-L-shell transitions in multiply charged chlorine ions. Forester, J.P.; Pegg, D.J.; Griffin, P.M.; Alton, G.; Elston, S.B.; Hayden, H.C.; Thoe, R.S.; Vane, C.R.; Wright, J.J. (University of Tennessee, Knoxville, Tennessee 37916). *Phys. Rev., A;* **18**: No. 4, 1476-1480(Oct 1978).

A systematic study of radiative lifetimes of low-lying levels in Cl XV through Cl IX has been made using the beam-foil time-of-flight techniques. These results are used to derive f values for allowed $\Delta n = 0$ transitions of the type 2s^{2}2p/sup k/-2s2p/sup k/+1 and 2s2p/sup k/+1-2p/sup k/+2.

1676 Kinetic-energy distribution of excited atoms produced when H_2 and D_2 molecules are dissociated by electron impact. Polyakova, G.N.; Ranyuk, A.I.; Erko, V.F. (Physicotechnical Institute, Ukrainian Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1117-1121(Dec 1977).

The kinetic-energy distributions are investigated of excited hydrogen and deuterium atoms in states with principal quantum numbers n=3,4,5, and 6, produced in the dissociation of H_2 and D_2 molecules by electron impact with energy 90—300 eV. It is shown that the dissociative excitation of the H_2 and D_2 molecules results in two groups of atoms, slow and fast. The relative number of the slow and fast atoms depends on the principal quantum number and on the molecule mass. The dependence on the molecule mass points to an important role of the predissociation process in the formation of the group of slow fragments.

1677 Experimental study of the loss and capture of electrons by fast multiply charged nitrogen and neon ions in various gases. Dmitriev, I.S.; Tashaev, Y.A.; Nikolaev, V.S.; Teplova, Y.A.; Popov, B.M. (Nuclear Physics Institute of the Moscow State University). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 884-890(Nov 1977).

Measurements were made of the cross sections for the loss and capture of one or two electrons by nitrogen and neon ions with charges from 1 to 7 or 8 as they pass through helium, nitrogen, neon and argon with velocities v equal to 2.7×10^8, 4×10^8, and 8×10^8 cm/sec. At v< or =4×10^8 cm/sec a substantial difference was observed between the cross sections for electron capture in states with different values of the principal quantum number n at equal binding energies. A nonmonotonic dependence of the investigated cross section of the charge Z/sub c/ of the nuclei of the atoms of the medium at $v \sim 10^9$ cm/sec is observed and investigated.

1678 Cross sections of transitions betwen highly excited levels as a result of collisions with charged particles. Beigman, I.L. (P. N. Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 908-912(Nov 1977).

A quasiclassical description of a highly excited atomic electron is used to find the transition cross section in terms of the Born amplitudes in the impact parameter representation. The amplitudes are found in the momentum transfer representation by means of asymptotically accurate (in respect of the principal quantum number n) Born amplitudes. The results are given of numerical calculations for transitions from the n=10 and n=100 states. The feasibility of comparison of these results with experiments is considered.

1679 Formation of quasimolecules in heavy-ion collisions. Kaun, K.; Manfrass, P.; Frank, W. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 6, 512-528(Nov 1977).

The present state of experimental investigations of quasimolecules formed transiently in collisions between accelerated heavy ions and atoms is reviewed: the properties of the quasimolecular x-ray emission of these systems, the spectral distribution and structure of the observed x-ray continua, and their angular anisotropy. Consideration is given to the possibility of using systems formed in heavy-ion collisions to study the electron states of superheavy molecules with effective atomic number Z>>100, in particular the possibility of spontaneous creating of electron-positron pairs and decay of the neutral vacuum in a supercritical field when Z> or $\approx$172.

ATOMIC AND MOLECULAR THEORY

REFER ALSO TO CITATION(S) 1255

1680 Comparison of multiple-photon excitation models. Galbraith, H.W.; Ackerhalt, J.R. (Theoretical Division, Los Alamos Scientific Laboratory, New Mexico 87545). *Opt. Lett.;* **3**: No. 4, 152-153(Oct 1978).

Two recent detailed models of multiple-photon excitation in SF_6 are compared. By performing equivalent vibration-rotation calculations using the two different basis sets, we have found that the results are in complete agreement. Rotational effects in both cases completely overshadow the vibrational structure, making a triply degenerate anharmonic oscillator model sufficient for describing multiple-photon excitation in SF_6.

1681 Single-photon transition moments in excited states of spherical-top molecules. Galbraith, H.W. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, P. O. Box 1663, Los Alamos, New Mexico 87545). *Opt. Lett.;* **3**: No. 4, 154-155(Oct 1978).

Single-photon transition moments for overtone states of triply degenerate modes of spherical-top molecules applicable to multiple-photon dynamics calculations are derived for zeroth- and first-order theories. In each case the total transition strength for for excitation out of a given angular momentum state is in agreement with well-known results for the triply degenerate oscillator. In contrast with recently published results, this work shows that all strongly allowed multiple-photon pathways do occur.

FLUID PHYSICS

1682 (LA-UR—78-757) **Spherical shock collapse in a non-ideal medium.** Axford, R.A.; Holm, D.D. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 11p. (CONF-780831—1). Dep. NTIS, PC A02/MF A01.

From Symposium on group theoretical methods in mechanics; Novosibirsk, USSR (25 Aug 1978).

Non-ideal fluid motions are studied. Spherical self-similar convergence is calculated for a strong shock in an ideal medium. Group theory is used to place a symmetry condition on the adiabatic bulk modulus, B/sub s/(p,v), for which three independent scale transformations of Euler's equations are admitted. The types of non-ideal media which satisfy the bulk modulus symmetry condition include equations of state of Mie-Grusneisen type. Thus the theory applies to a wide class of materials. In particular it applies to non-degenerate solids at shock pressures well above the yield stress. (GHT)

GENERAL FLUID DYNAMICS

1683 (UCID—17875) **Molecular dynamic results on transport properties.** Alder, B.J.; Alley, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1978. Contract W-7405-ENG-48. 62p. Dep. NTIS, PC A04/MF A01.

Following a broad discussion of generalized hydrodynamics, three examples are given to illustrate how useful this approach is in extending hydrodynamics to nearly the scale of molecular dimensions and the time between collisions, principally by including viscoelastic effects. The three examples concern the behavior of the velocity autocorrelation function, the decay of fluctuations in a resonating system, and the calculation of the dynamic structure factor obtained from neutron scattering. In the latter case the molecular dynamics results are also compared to the predictions of generalized kinetic theory. Finally it is shown how to implement generalized hydrodynamics both on a microscopic and macroscopic level. Hydrodynamics is unable to account for the long time tails in the velocity autocorrelation functions and the divergent Burnett coefficients observed for the Lorentz gas. Instead, the long time behavior of the Burnett coefficient and the distribution of displacements (the self part of the dynamic structure factor) can be accounted for by a random walk with a waiting time distribution which is chosen to give the correct velocity autocorrelation function. This random walk predicts, in agreement with the observations, that this displacement distribution is Gaussian at long times for the Lorentz gas, while for hard disks it has been found not to be so.

1684 Two-dimensional fluid-transient analysis by the method of nearcharacteristics. Shin, Y.W.; Kot, C.A. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Comput. Phys.;* **27**: No. 4, 211-231(Aug 1978).

A numerical technique based on the method of nearcharacteristics is used for solving nonlinear fluid-transient problems in two-dimensional plane or axisymmetric geometries. The solution procedure is constructed by relating flow conditions through compatibility relations along nearcharacteristic lines which lie in coordinate planes. This leads to an efficient computational technique which is a direct extension of the one-dimensional method of characteristics and which requires only simple one-dimensional interpolations. Because the nearcharacteristics fall outside the characteristic cone, the solution procedure refers directly to conditions outside the true domains of dependence. However, numerical calculations for simple example problems and comparisons with analytical and experimental results show that the nearcharacteristic procedure is in general as accurate as the bicharacteristic method. Von Neumann stability analysis for a linearized version of the numerical procedure reveals that the schemes based on a formulation in a single coordinate plane are unconditionally unstable. However, averaging the two unstable solutions yields a stable procedure with a stability criterion equivalent to that of the bicharacteristic procedure ($c\Delta t/\Delta x <$ or $=0.5$). Numerical experimentation verifies that these findings for the linearized system also apply to the nonlinear procedures. The ease of formulation of the nearcharacteristic equations and the numerical schemes, even for problems involving large numbers of independent variables or multitudes of characteristics, makes this technique at-

tractive for application where alternate methods of characteristic approaches become too cumbersome or outright impossible.

1685 Bubble growth in variable pressure fields. Jones, O.C. Jr; Zuber, N. (Head Thermal Hydraulic Development Division, Department of Nuclear Energy, Brookhaven National Laboratory, Upton, N. Y.). *J. Heat Transfer;* **100**: No. 3, 453-459(Jul 1978).

The case of a spherical vapor bubble growing in an infinite, uniformly heated liquid, has been analyzed under the thin boundary layer approximation for the effects of a variable pressure effects can be quite important and dominate the rate of growth. For the case where pressure changes cause the vapor temperature to behave as t/ sup n/, (t being time), the bubble radius will grow as t/sup n+1/2/, significantly faster than the √t behavior usually expected. The analysis has been shown to compare favourably with existing data.

PROPERTIES AND STRUCTURE OF FLUIDS

1686 Moessbauer scattering from a supercooled liquid. Soltwisch, M.; Elwenspoek, M.; Quitmann, D. (Freie Univ., Berlin). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 114-117(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

By a coherent Moessbauer-scattering experiment, the dynamical structure factor $S(k,\omega)$ was determined for pure liquid glycerol. As a function of temperature ($-30^0C \leq T \leq 0^0C$) and momentum transfer ($0.7A^{-1} \leq k \leq 4A^{-1}$) the width and intensity of the quasielastic line and the intensity of the inelastic line were measured. From the ratios of the intensities the mean-square vibrational amplitude of the molecules was derived while from the linewidth of the quasielastic part translational and rotational diffusion parameters were extracted.

MAGNETOHYDRODYNAMICS

REFER ALSO TO CITATION(S) 896

SUPERFLUIDITY

1687 Incipient superfluidity in liquid ^{3}He above the superfluid transition temperature. Paulson, D.N.; Wheatley, J.C. (Department of Physics, University of California, San Diego, La Jolla, California 92037). *Phys. Rev. Lett.;* **41**: No. 8, 561-564(21 Aug 1978).

The large zero-sound attenuation just below the transition temperature T/sub c/ to a superfluid state in liquid ^{3}He is anticipated above the transition by an excess attenuation over that for a normal Fermi liquid. The excess is greatest at T/sub c/ but can be readily discerned at temperature several percent above T/sub c/. The excess is largest near melting pressure and exists adjacent to both ^{3}He-A and ^{3}He-B.

1688 Theory of degenerate ^{3}He—He II solutions. Bashkin, E.P. (Institute of Physics Problems, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 972-980(Nov 1977).

We consider a degenerage solution of ^{3}He in superfluid ^{4}He from the point of view of the properties of fermion systems with short interaction ranges. We obtain all terms of the expansion of thermodynamic quantities and kinetic coefficients in powers of x/sup 1/3/, where x is the molar concentration, for the case where the properties of the solution are determined by specifying only a single parameter: the s-wave scattering length a. Comparison with experimental data shows that the theory proposed here describes the solution well up to concentrations of the order of 3 to 4%. We evaluate the propagation speeds of spin waves, of hydrodynamic and of high-frequency sound oscillations.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

1689 (JINR-D—1,2-10400, pp A2.17-A2.20) **Two-particle correlations.** Kistenev, E.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Progress in correlation studies makes it obvious that a real understanding of the phenomena responsible for the structure observed in correlations is impossible without precise separation of the production mechanisms playing a dominant role in different regions of the phase space. For this reason the paper is devoted to those results which provide information about the interplay between the correlation and production dynamics. The presented data support the existence of the positive short-range correlations in rapidity space for both like and unlike charge combination. The dependence of the semi-inclusive correlation function can be parametrized in the framework of the independent cluster emission model with cluster multiplicity $(K) <= 2$, which means that the resonance can play a dominant role in the longitudinal correlations. The angular correlations observed in the $\pi\pi$ systems are mainly of kinematic origin. The difference between the like and unlike charge pairs apart from the threshold region where the interference effects could be essential can be explained by resonance production.

1690 (JINR-D—1,2-10400, pp A2.32-A2.34) **Inclusive reactions at medium energies.** Kittel, W. (Katholieke Universiteit Nijmegen (Netherlands)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The author discusses results on strange baryon production in inclusive reactions at medium energies. Polarization of the Λ^0 and Ξ^- is studied. Results are in qualitative agreement with the triple Regge diagrams. The effective trajectories in triple-Regge diagrams are presented. At medium energies the mass distribution of strange baryons is dominated by resonance production.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 1705, 1733

1691 (JINR-D—1,2-10400, pp C90-C93) **Recent results from MINA.** Allison, J. (Manchester Univ. (UK)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Recent results from MINA are presented. The Lancaster group have studied nuclear photoproduction of rho, ω mesons on Be, C, Al, Cu, Ag, Au targets in the energy range of 2.75 to 4.35 GeV. A Daresbury-Sheffield group have studied backward photoproduction of rho^0 and f in the reaction of $\gamma p \rightarrow p \pi^+ \pi^-$ with a tagged photon beam of energy between 2.8 and 4.8 GeV. A series of single and double polarization experiments has been made by the Glasglw-Liverpool-Sheffield collaboration on the reactions $\gamma p \rightarrow \pi^+ n$, $\gamma p \rightarrow \pi^0 p$ and $\gamma p \rightarrow$ eta p at various incident beam energies between 0.6 and 3 GeV. Various polarization parameters have been measured. The π^+ n coincidence data on threshold π^+ electroproduction is reviewed. These data are from the Daresbury-Pisa-Rome collaboration. The inclusive neutron spectra in electroproduction above the resonance region at momentum transfers of 0.3,06 and 0.9 GeV^2 and a c.m.s. energy of 2.3 GeV are presented.

1692 (JINR-D—1,2-10400, pp A7-5-A7-7) **Measurement of the nucleon and pion form factors in the region of time-like 4-momentum transfers from 1.5 F^{-2} to 3.0 F^{-2}.** Berezhnev, S.F.; Blokhintseva, T.D.; Demyanov, A.V.; Kuptsov, A.V.; Kurochkin, V.P.; Nemenov, L.L.; Smirnov, G.I.; Khazins, D.M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The experimental investigation of the reaction of $\pi^- + p \rightarrow e^+ + e^- + n$ inverse electroproduction of pions (IEP) has been made at the pion energy of 275 MeV. To analyze the experimental data the dispersion model has been used. The $F_1/sup\ \nu/K^2$ and F/sub π/K^2) form factors have been taken as varying parameters upon which differential cross sections are greatly dependent. For part of statistics a phenomenological analysis of data is presented. It allows determination of the contributions of states with various photon polarizations to the IEP differential cross section. The cross section of process with transverse nonpolarized virtual sigma$_t$ gamma quanta depends equally on the Dirac isovector Fsub(1)sup(v) form factor of the nWcleon and the pion Fsub(π) form factor. The value of the sigma$_4$ cross section of processes with longitudinally polarized photons depends mainly upon $F_1/sup\ \nu/$. Thus, if the value of sigma$_4$ is known with a small error, $F_1/sup\ V/$ can be determined with a good accuracy even when a rough estimation of the form factor F/sub π/ is used.

1693 (JINR-D—1,2-10400, pp C22-C25) **D(1285) and E(1420) mesons.** Bottcher, H. (Akademie der Wissenschaften der DDR, Berlin-Zeuthen. Inst. fuer Hochenergiephysik). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The D(1285) and E(1420) mesons have been known since 1965 and 1967, respectively. Evidence is presented for the D(1285) meson in its (K anti K π), (rho π π) and (eta π π) decay mode. The decay of the D(1285) into (eta π π) proceeds mainly via the D $\rightarrow$ delta π $\rightarrow$ eta π π chain. The branching fraction ranges from about 0.5 to 1.0. New values for the mass and width of the D(1285) core given. A new value for the branching ratio of (D $\rightarrow$ rho π π) (D $\rightarrow$ eta π π) and upper limit for (D $\rightarrow$ K anti K π)/(D $\rightarrow$ eta π π) are derived. Spin and parity of the D meson are not yet established. The evidence for the E(1420) is very weak. Its existence is questionable.

1694 (JINR-D—1,2-10400, pp A7-27-A7-29) **Small-angle Compton scattering on hydrogen and deuterium.** Criegee, L.; Franke, G.; Ciese, A.; Kahl, Th.; Poelz, G.; Timm, U.; Werner, H.; Zimmermann, W. (Karlsruhe Univ. (TH) (Germany, F.R.)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

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Compton scattering has been measured on hydrogen at 6 GeV and in a second slightly modified experiment on hydrogen and deuterium at 5 GeV, both at particularly small momentum transfers ranging from -0.004 to -0.08 $(GeV/c)^2$ at 6 GeV and from -0.002 to -0.06 (GeV/c^2) at 5 GeV. For differential cross sections determined in this way only statistical errors are shown. The extrapolated forward cross sections are presented as a function of energy. For comparison with prediction of the vector dominance model (VDM) the forward cross section has been calculated using the sum rule with recent values for the vector meson cross sections, and the Orsay values for the coupling constants. The data are higher by about 40% than the VDM predictions. The isospin ratios are calculated.

1695 (JINR-D—1,2-10400, pp A7-8-A7-10) **Measurement of the pion form factor.** Dally, E.; Hauptman, J.; May, C. (California Univ., Los Angeles (USA)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The pion form factor has been measured in the momentum transfer range of $0.03 <= q <= 0.07$ $(GeV/c)^2$ by scattering pions from atomic electrons in a liquid hydrogen target. The pion form factor is defined to be the elastic scattering cross section divided by that predicted for a point pion. The experiment has been performed in a 100 GeV/c negative pion beam incident on a 50 cm liquid hydrogen target at Fermi laboratory. The corrected form factor equals 0.33 +- 0.06 f^2. Vector dominance predicts 0.40 f^2.

1696 (JINR-D—1,2-10400, pp A7.22-A7.24) **Nucleon axial vector form factor from threshold π^+ electroproduction.** Norton, P.R. (Science Research Council, Daresbury (UK). Daresbury Lab.). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Data from two experiments for determination of the nucleon axial vector form factor from π^+ electroproduction are considered. The axial vector form factor is derived from the measured cross section. The first experiment has been performed at momentum transfers of 0.45, 0.58 and 0.88 $(GeV/c)^2$. The result 0.96 +- 0.03 GeV is in excellent agreement with quasi-elastic neutrino scattering. New data are presented from a single-arm experiment at 3.5, 5.0 and 8.0 F^2, in which the longitudinal and transverse contributions to the threshold cross section slope have been separated by varying the virtual photon polarization. The values deduced from the transverse cross section are in good agreement with previous coincidence data.

1697 (JINR-D—1,2-10400, pp C93-C96) **Photo and electroproduction of pions in the first πN-resonance range.** Sorokin, P.V. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). 1977. (In Russian).

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

A great deal of attention has been paid recently to investigation of the processes of pion photo- and electroproduction on nucleons in the energy range up to 500 MeV. Preliminary results of three papers dealing with photoproduction and electroproduction of pions on nucleons are presented in this paper. In the first experiment recoil proton polarization in the $\gamma p \rightarrow \pi^0 p$ reaction on a linear polarized proton beam has been measured. The second experiment made it possible to obtain new data on the asymmetry in the $\gamma d \rightarrow \pi^0 d$ reaction cross section. New theoretical calculations of the $\gamma d \rightarrow \pi^+$ 2N process are performed and a comparison with the experimental results is made. Within the framework of the existing theories it is evidently, difficult to receive data on neutron cross sections from experiments with deuterium and to provide the accuracy of the data better than approximately 10%. Transverse and longitudinal multipoles have been newly estimated from the cross section for pion electroproduction on a proton near the threshold in "one shoulder" experiment.

1698 (JINR-D—1,2-10400, pp C96-C98) **Results of polarization experiments on photoproduction of π and eta mesons in the 0,7-1,8 GeV range.** Vartapetyan, G.A. (Erevanskij Fizicheskij Inst. (USSR)). 1977. (In Russian).

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Results of study on π- and eta-meson photoproduction in the range 0.7-1.8 GeV are presented. Asymmetry in the reaction $\gamma p \rightarrow \pi^0 p$ is measured in the energy range 0.8-1.3 GeV at the angle THETA = 60 deg. Asymmetry in the reaction $\gamma p \rightarrow \pi^+ n$ is measured in the energy range 0.5-0.8 GeV at the angle THETA = 40 deg - 160 deg. Results of the measurements in both cases are compared with data on preliminary analysis. Asymmetry of the eta-meson photoproduction by the polarized photons in measured at energies 1.39; 1.53; 1.78 GeV and at angle 45 deg. Comparison of results on asymmetry at energy 1.78 GeV with data of the analysis shows that the amplitude of the eta-meson photoproduction has the Regge behavior already at the energy 1.8 GeV.

1699 (JINR-D—1,2-10400, pp A7.1-A7.5) **Elastic and inelastic electron scattering from a deuteron at large momentum transfer.** Chertok, V.T. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The problem can be divided into three sections: the asymptotic elastic form factors of hadrons and nuclei, and the continuity of particle and nuclear dynamics; measurement of inelastic e-D scattering in the threshold region at large momentum transfer; measurement of the magnetic form factor of the deuteron at $q^2 = 1$ GeV. The large q^2 behavior of the elastic form factor (F) of a hadron or a nucleus is related by dimensional counting to the number of its elementary constituents. A simple model predicts that, for large q^2, $F(q^2)$ approximately = (1-qsup(2)/msub(n)sup(2))sup(1-n), where msub(n)sup(2) is proportional to the number of constituents (n). At $0.8 (<=) q^2 (<=) 6.0$ $(GeV/C)^2$ nine spectra of inelastic electron deuteron scattering were measured in the threshold region below the elastic peak. The deuteron inelastic structure was extracted from those data. It is approaching a universal scaling curve, and there is a close relation between deuteron elastic and inelastic structure functions. At $q^2 = 1 (GeV/c)^2$ the elastic scattering of electrons on deuterons was measured at electron scattering angles of 8 deg, 60 deg and 82 deg. From these data a value of magnetic structure function of $B(q^2) = 1.55 +- 10x10^{-5}$ for deuteron is extracted.

1700 **Inclusive hadron production in e^+e^- annihilation at $< s > = 53$ GeV^2.** Aschman, D.G.; Coyne, D.G.; Groom, D.E.; O'Neill, G.K.; Sadrozinski, H.F.W.; Shinsky, K.A.; Badtke, D.H.; Barnett, B.A.; Jones, L.H.; Zorn, G.T.; Cavalli-Sforza, M.; Goggi, G.; Impellizzeri, F.S.; Livan, M.; Pastore, F.; Rossini, B.; Keller, L.P. (Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **41**: No. 7, 445-448(14 Aug 1978).

We report on inclusive hadron production in e^+e^- annihilation at $< s <$ or $= = 53$ GeV^2, using a small solid-angle magnetic spectrometer with good particle identification at 90° to the beams at SPEAR II. The cross sections of π^{+-} and K^{+-} when compared with data at $s = 23$ GeV^2 exhibit scaling in (s/β) $d\sigma/dx$ with $x = 2E/s/$ sup 1/2/. The invariant cross section depends on the momentum as p^{-4}.

1701 **Limits on strength of neutral currents from $e^+e^- \rightarrow \mu^+\mu^-$.** Himel, T.; Richter, B.; Abrams, G.S.; Alam, M.S.; Boyarski, A.M.; Breidenbach, M.; Chinowsky, W.; Feldman, G.J.; Goldhaber, G.; Hanson, G.; Jaros, J.A.; Larsen, R.R.; Lueke, D.; Lueth, V.; Schindler, R.; Schwitters, R.F.; Siegrist, J.L.; Trilling, G.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **41**: No. 7, 449-451(14 Aug 1978).

The reaction $e^+e^- \rightarrow \mu^+\mu^-$ has been measured in the center-of-mass energy range 5.8—7.4 GeV. The polar-angle asymmetry agrees with second-order quantum electrodynamics. From this a 95% confidence limit of M/sub z/ > 53g/sub a//e GeV is placed on the mass to coupling constant ratio for a neutral vector boson.

WEAK INTERACTIONS

1702 (BNL—24536) **Lepton and charm production in the 15 foot FNAL bubble chamber.** Cnops, A.M.; Palmer, R.B.; Baltay, C. (Brookhaven National Lab., Upton, NY (USA); Columbia Univ., New York (USA)). 1978. Contract EY-76-C-02-0016. 24p. (CONF-780353—3). Dep. NTIS, PC A02/MF A01.

From 13. high energy hadronic interactions sessions; Les Arcs, France (12 Mar 1978).

The report is on ν interactions in the FNAL 15 foot bubble chamber filled with heavy neon. Inclusive production of π^+, π^-, K^0 and Λ^0 is shown. Limits are given on the production and hadronic decay of A/sub c/. The rate of D^0 production and decay to $K^0\pi^+\pi^-$ is reported. Events containing a μ^- and e^+ are observed and interpreted as leptonic decay of charm. Events with single e^+ or e^- are reported and found to be consistent with anti ν/sub e/ and ν/sub e/ interactions.

1703 (BNL—24663) **Recent results from neutrino interactions in heavy neon.** Baltay, C.; Caroumbalis, D.; French, H. (Columbia Univ., New York (USA); Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 22p. (CONF-780453—10). Dep. NTIS, PC A02/MF A01.

From Neutrinos; West Lafayette, IN, USA (28 Apr 1978).

Recent results are reported from an analysis of 100,000 pictures of the Fermilab 15 ft. bubble chamber filled with heavy neon and exposed to the double horn focused, wideband ν/sub μ/ beam. There were 164 dilepton (μ^-e^+) events with 33 vees, in good agreement with the GIM model of charm production. Also the production of the charmed D^0 meson, followed by the decay $D^0 \rightarrow K^0\pi^+\pi^-$, at a rate of (0.7 +- 0.2)% of all charged current events were observed. Searches were carried out for charm changing neutral current processes and for heavy lepton production, both with negative results; the upper limits obtained in these searches are given.

1704 (BNL—24664) **Observation of the process ν/sub μ/ + e^- $\rightarrow$ ν/sub μ/ + e^- at high energies.** Baltay, C.; Caroumbalis, D.; French, H. (Columbia Univ., New York (USA); Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 5p. (CONF-780453—9). Dep. NTIS, PC A02/MF A01.

From Neutrinos; West Lafayette, IN, USA (28 Apr 1978).

There were 5 events of the reaction ν/sub μ/ + $e^- \rightarrow \nu$/sub μ/ + e^- in a sample of approximately 50,000 charged current neutrino interactions in a heavy neon-hydrogen mixture in the 15 foot bubble chamber at Fermilab. This result is in rough agreement with the prediction of the Weinberg-Salam model with the currently favored value of the mixing angle, $\sin^2$ theta approximately 1/4.

1705 (COO—3064-5) **Experimental studies of the acoustic detection of particle showers and neutrino physics beyond 10 TeV.** Sulak, L.R. (Harvard Univ., Cambridge, MA (USA)). 1977. Contract EY-76-C-02-3064. 20p. (CONF-770319—13). Dep. NTIS, MF A01.

From 12. Rencontre de Moriond; Haute-Savoie, France (6 Mar 1977).

Portions of document are illegible.

The physics of deep inelastic scattering induced by atmospheric neutrinos of approximately 10 TeV energy is discussed. A 10^9 ton water detector at great depth in the ocean, utilizing acoustic signals from the secondary showers and muon, is investigated. Recent results from Brookhaven and Harvard on the sonic signature produced by particles in water are presented. This work suggests that the 10^9 ton detector is feasible, and that energy depositions in the laboratory as small as 10 GeV may eventually be observable by this technique.

1706 (SLAC-PUB—2138) **Properties of the tau lepton.** Feldman, G.J. (Stanford Linear Accelerator Center, CA (USA)). Jun 1978. Contract EY-76-S-03-0326. 17p. (CONF-780453—12). Dep. NTIS, PC A02/MF A01.

From Neutrinos; West Lafayette, IN, USA (28 Apr 1978).

The measured properties of the tau lepton and its neutrino are reviewed. A constrained fit to the world data gives a tau branching fraction to an electron plus neutrinos (B/sub e/) of (17.4 +- 2.1)% and B/sub mu//B/sub e/ = 1.07 +- 0.17. New data on the tau $\rightarrow$ pi nu mode are in agreement with the expected branching fraction. There is evidence for the tau $\rightarrow A_1$ nu mode, but the A_1 resonance cannot be conclusively established from the current data. The DELCO experiment establishes the tau mass to be 1782 /sup +2// sub -7/ MeV/c^2 and the nu/sub tau/ mass to be less than 250 MeV/c^2. It also excludes V + A as a tau - nu/sub tau/ coupling and strongly favors V - A.

1707 **Scaling-variable distributions in deep-inelastic antineutrino-proton interactions.** Barish, S.J.; Brock, R.; Engler, A.; Keyes, G.; Kikuchi, T.; Kraemer, R.W.; Derrick, M.; Gregory, P.; Hyman, L.G.; Jaeger, K.; Miller, R.J.; Musgrave, B.; Phelan, J.J.; Schreiner, P.; Singer, R.; Barnes, V.E.; Carmony, D.D.; Garfinkel, A.F.; Laasanen, A.T. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **18**: No. 7, 2205-2222(1 Oct 1978).

We present an analysis of scaling-variable distributions in deep-inelastic antineutrino-proton interactions. The data sample of 351 antineutrino-proton and 122 neutrino-proton charged-current events was obtained from exposures of the 15-foot hydrogen bubble chamber to the wide-band antineutrino beam at Fermilab. The methods used to select the muon track and estimate the beam energy for each event are discussed in detail. We observe no energy dependence in the shape of the antineutrino Y distribution; for a mean nu-bar energy of 31 GeV, we measure the shape parameter B = 0.76 +- 0.11. The distributions in the scaling variables X, V, and W are in reasonable agreement with the predictions of the quark-parton model. In addition, we measure the ratio R/sub p/ = σ (nu-bar + p $\rightarrow \mu^+$ + ...)/ σ (ν + p $\rightarrow \mu^-$ + ...) = 0.79 +- 0.14, consistent with the value expected for this model.

1708 **Search for parity violation in deep-inelastic scattering of polarized electrons by unpolarized deuterons.** Atwood, W.B.; Cottrell, R.L.A.; DeStaebler, H.; Miller, R.; Pessard, H.; Prescott, C.Y.; Rochester, L.S.; Taylor, R.E.; Alguard, M.J.; Clendenin, J.; Cooper, P.S.; Ehrlich, R.D.; Hughes, V.W.; Lubell, M.S.; Baum, G.; Schueler, K.P.; Luebelsmeyer, K. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **18**: No. 7, 2223-2226(1 Oct 1978).

We report on recent asymmetry measurements for inelastic scattering of longitudinally polarized electrons from an unpolarized deuterium target at 19.4 GeV. Using the SLAC 20-GeV/c and 8-GeV/c spectrometers, the helicity-dependent cross-section asymmetries were measured at Q^2 values of 1.2 and 4.2 GeV/c^2, and were found to be less than 2×10^{-3} and 7×10^{-3}, respectively.

1709 **Evidence for the production of prompt like-sign dimuon events by high-energy neutrinos.** Benvenuti, A.; Bobisut, F.; Cline, D.; Cooper, P.S.; Gilchriese, M.G.D.; Heagy, S.M.; Imlay, R.; Johnson, M.; Ling, T.Y.; Lundy, R.; Mann, A.K.; McIntyre, P.; Mori, S.; Reeder, D.D.; Rich, J.; Stefanski, R.; Winn, D.R. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.;* **41**: No. 11, 725-728(11 Sep 1978).

We report the observation of 46 $\mu^-\mu^-$ events in high-energy neutrino-nucleon collisions at Fermilab. Measurement of the production rate of the $\mu^-\mu^-$ events relative to that of $\mu^-\mu^+$ events in targets of different hadronic absorption lengths give N/sup prompt/($\mu^-\mu^-$)/ N/sup prompt/($\mu^-\mu^+$) = 0.06 +- 0.05 for p/sub μ/ > 5 GeV/c, and 0.12 +- 0.05 for p/sub μ/ > 10 GeV/c. The properties and possible origins of these events are discussed.

1710 **Muon scattering at 219 GeV and the proton structure functions.** Gordon, B.A.; Quirk, T.W.; Anderson, H.L.; Booth, N.E.; Francis, W.R.; Hicks, R.G.; Kinnison, W.W.; Kirk, T.B.W.; Loomis, W.A.; Matis, H.S.; Mo, L.W.; Myrianthopoulos, L.C.; Pipkin, F.M.; Proudfoot, J.; Sessoms, A.L.; Shambroom, W.D.; Skuja, A.; Staton, M.A.; Tao, C.; Williams, W.S.C.; Wilson, R.; Wright, S.C. (Enrico Fermi and University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **41**: No. 9, 615-618(28 Aug 1978).

Results on the proton structure function, F_2, are presented for $0.3 < q^2 < 80,0$ GeV^2 and $10 < \nu < 200$ GeV. The results support the conclusions of earlier work at 97 and 147 GeV that scaling is violated. A new value for R = σ/sub s//σ/sub T/ = 0.44 +- 0.25 has been obtained using all the Fermilab proton measurements.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 1703, 1738, 1739, 1746, 1843

1711 (JINR-D—1,2-10400, pp A2-42-A2-78) **Multiparticle and inclusive reactions.** Chliapnikov, P.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

An enormous number of experimental and theoretical results have been obtained within recent years in the field of multiparticle production. The following subjects are reviewed: total inclusive cross sections; the approach to scaling in the fragmentation and central regions; inclusive resonance production (total cross sectionS, differential cross sections, mechanisms); two-particle correlations (angular correlations, space structure of events). Limiting fragmentation hypothesis is compatible with the present trend of data at the highest accelerator energies within approximately 10% errors. The Pomeron factorization seems to hold with the same accuracy at low momentum transfers. However, for $-t>0.5$ (GeV/c)^2, pronounced breakdown in factorization is indicated between the elastic and inelastic diffraction cross sections. The dramatic violation of scaling is firmly established in the central region. There is a strong evidence

that hadron-hadron reactions are dominated by resonance production. As a consequence the cluster and the short-range order correlation effects may be to a large extent explained by resonance production.

1712 (JINR-D—1,2-10400, pp A4-6-A4-8) **Large transverse momentum photons from high energy proton-proton collisions.** Darriulat, P.; Dittman, P.; Eggert, K. (Joint Inst. for Nuclear Research, Dubna (USSR)) (and others). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

A simultaneous measurement is reported of the yields of single photons and of photon pairs produced in proton-proton collisions of total c.m. energies of $\sqrt{S}$=45 and 53 GeV. Large transverse momentum photons produced in this reaction have been assumed earlier as products of π^0 or eta decay. This experiment must clarify the situation. The photon detector is a lead glass hodoscope located at 90 deg production angle in a intersection region of CERN ISR. 12-13% of the observed single photon spectrum is explained by eta decay. The ratio of the single photon yield in excess to that from π^0 and eta decays to the π^0 yield itself amounts to 20% for both values of $\sqrt{S}$.

1713 (JINR-D—1,2-10400, pp A4-23-A4-42) **Large transverse momentum hadronic processes.** Darriulat, P. (European Organization for Nuclear Research, Geneva (Switzerland)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The possible relations between deep inelastic leptoproduction and large transverse momentum (p/sub t/) processes in hadronic collisions are usually considered in the framework of the quark-parton picture. Experiments observing the structure of the final state in proton-proton collisions producing at least one large transverse momentum particle have led to the following conclusions: a large fraction of produced particles are uneffected by the large p/sub t/ process. The other products are correlated to the large p/sub t/ particle. Depending upon the sign of scalar product they can be separated into two groups of "towards-movers" and "away-movers". The experimental evidence favoring such a picture is reviewed, and the properties of each of three groups (underlying normal event, towards-movers and away-movers) are discussed. Some phenomenological interpretations are presented. The exact nature of away- and towards-movers must be further investigated. Their apparent jet structure has to be confirmed. Angular correlations between leading away and towards movers are very informative. Quantum number flow, both within the set of away and towards-movers, and between it and the underlying normal event, are predicted to behave very differently in different models.

1714 (JINR-D—1,2-10400, pp A2-3-A2-6) **Multiple production in anti pp interactions.** Gramenitskii, I.M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977. (In Russian).

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

A review of the investigations on the parameters characterized the multiplicity of anti pp interactions up to 100 GeV/c is presented. The angular correlations for reactions anti pp→$2\pi^+2\pi^-$, $2\pi2\pi^-\pi^0$ and $2\pi^+2\pi^-$ ($m\pi^0$) at 5,7 GeV/c are studied. The cross sections of some channels of reactions, total cross sections of annihilation into pions, cross sections of production of the rho^0, ω^0 and Δ^{++}(anti Δ^{++}) isobar at 9,1 GeV/c are determined. The cross sections of K^0, Λ, anti Λ and π^0 mesons production are studied from 4 up to 32 GeV/c.

1715 (JINR-D—1,2-10400, pp A1.17-A1.18) **Antiproton small momentum transfer charge exchange scattering on protons at 30 GeV/c.** Isakov, V.V.; Kakauridze, D.B.; Khaustov, G.V.; Postoev, V.E.; Prokoshkin, Yu.D.; Startsev, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Antiproton charge exchange scattering on protons anti pp→anti nn is investigated with 30 GeV/c antiprotons at the IHEP accelerator. The experiment confirms the existence of a structure at small angles in the angular distribution of this reaction at high energies, observed earlier.

1716 (JINR-D—1,2-10400, pp A1.7-A1.10) **Nucleon diffraction dissociation (experiment).** Kamyshkov, Yu. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The present situation in nucleonic diffraction dissociation into the ($N\pi$) system is discussed. New experimental data have come mainly from experiments performed at high energies by electronics technique at Serpukhov, FNAL and ISR with high statistics. There are three arguments for the existence of baryon-exchange Deck mechanism. The results show the existence of the correlation between production and decay of (πN) system. At least partially these correlations can be explained kinematically. The mass distributions for experiments are compared. Sets of data are absolutely normalized. The spectra turned out to be almost identical apart from the mass range around 1.5 GeV.

1717 (JINR-D—1,2-10400, pp A1.3-A1.7) **High mass diffraction excitation of protons on protons and electrons.** Mukhin, S.V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Some new results are discussed on the inclusive processes $p+p \to X+p$ and $p+d \to X+d$ in the kinematic range of $5 > = Mx^2 > = 0.25$ (GeV)^2, $S > 120$ GeV^2 and $t < 0.3$ (GeV/c)^2. The triple Pomeron exchange dominates in the pure diffraction mass range of $5 > = Mx^2 > = 0.055$ GeV^2. There are deviations from scaling for $S > = 600$ GeV^2 or for $t < 0.2$ (GeV/c)^2. The deviation from the 1/Msub(x)sup(2) behaviour for Msub(x)sup(2)/S (>=) 0.06 indicates a significant role of nondiffractive exchanges in this mass range. The similarity in the pp and pd mass spectra shows that the isospin = 0 exchange dominates. There are no dips, breaks, turnovers etc. in the t-dependence.

1718 (JINR-D—1,2-10400, pp A2.27-A2.29) **Experimental data on measurement of interaction range dimensions. Identity effect.** Podgoretskii, M.I. 1977. (In Russian).

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The modern state of the correlation method of determination of the radiation source dimension on the basis of experimental data is presented. Study of correlations of identical particles may give new data on properties of the strong interaction, if it is possible to raise their accuracy.

1719 (JINR-D—1,2-10400, pp A2.30-A2.32) **Multiple production above 10^{14} eV.** Roinishvili, N.N. (AN Gruzinskoj SSR, Tbilisi. Inst. Fiziki). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Results of contributions on multiple production above 10^{14} eV are presented. The main problem considered has been to find out whether the experimental data at very high energy (approximately 10^{15} eV) are in agreement with extrapolations of data obtained at accelerators (approximately 10^{12} eV). Results on extensive air showers, hadron families and nuclear-electromagnetic cascades in solid substances are discussed.

1720 (JINR-D—1,2-10400, pp C35-C38) **Investigation of the nature of enhancements observed in Λp effective mass spectra.** Shahbazian, B.A.; Temnikov, P.P.; Timonina, A.A.; Rozhdestvenskii, A.M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The inclusive Λp effective mass spectrum from interactions of 7 GeV/c average momentum neutrons with carbon nuclei has been investigated. Four enhancements have been discovered in it. It is suggested that they should be manifestations of peculiarities of the Λp elastic scattering and $\Lambda\Sigma$ and $\Sigma\Lambda$ conversion effective cross sections. To analyze this hypothesis a model of production and interactions of Λ and Σ hyperons in carbon nuclei has been developed. The analysis performed in the frame of this model permitted a successful description not only the Λp effective mass spectrum with its enhancements, but also the behavior of the Λp elastic scattering effective cross sections in the Λ hyperon relative momentum interval of (0.1-2.0) GeV/c. The peak near the Λp threshold is due to the negative sign Λp scattering length effect at low energy. The peaks at 2127 MeV/c^2 and 2257 MeV/c^2 are due to the Λp elastic narrow resonances at 620 MeV/c and 1120 MeV/c of relative Λ hyperon

momentum, respectively. The enhancement near 2184 MeV/c^2 is of a kinematic origin and is due to the two-step process $n^{12}C \rightarrow (\Sigma N) +$ anything, $\Sigma N \rightarrow \Lambda p$. The average range of the Λp interaction forces is about 0.66 fm.

1721 (JINR-D—1,2-10400, pp A4.1-A4.3) **Recent result on single particle high production at FNAL.** Shochet, M.J. (Chicago Univ., Ill. (USA)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The two experiments recently performed at the Fermi laboratory are reported. In one experiment high-transverse-momentum π^0's produced in π^{+-} p and pp collisions at incident energies of 100 and 200 GeV/c were measured. The second experiment presents preliminary data on the production of high-transverse-momentum particles from 200, 300, 400 GeV protons incident on H_2, D_2, Be, Ti and W targets. The main aim of the first experiment is a measurement of invariant cross section ratio $R(p/\pi^-)$ and $R(\pi^+/\pi^-)$ as a function of transverse momentum. The results are presented in a graphic form. In the second experiment the dependences of particle yield and invariant cross sections on the mass of the target-nucleus and transverse momentum investigated were. The results are approximated by analogous dependences for all nuclei excluding H_2.

1722 (JINR-D—1,2-10400, pp A4.3-A4.6) **Correlations in collisions with a high p/sub tr/ particle produced.** Sosnowski, R. (European Organization for Nuclear Research, Geneva (Switzerland); Institute of Nuclear Research, Warsaw (Poland)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The data obtained by three experimental groups who have analyzed collisions at 26+26 GeV with high-transverse-momentum secondaries by using the split field magnet (SFM) installed at the CERN ISR are discussed. It has been found in all three experiments that, whenever a high-transverse-momentum particle is detected, the probability to observe another particle emitted in the same direction increases. The observed excess of secondary particles above the distribution for normal collisions increases with the transverse momentum of the secondaries. The excess of particles in the region around the high-transverse-momentum particle decreases with the increase in the rapidity of the high-transverse-momentum particle. So, the higher is the transferse momentum of a triggering particle, the more numerous are the high transverse momentum particles in the azimuthal direction.

1723 (JINR-D—1,2-10400, pp A1.11-A1.14) **Spin dependence studies with the ZGS polarized proton beam.** Wicklund, A.B. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Selected results are summarized of recent measurements using a polarized proton beam at the Argonne ZGS. The polarized target asymmetry and the beam-target spin correlation are measured in $pp \rightarrow pp$ at 6 and 12 GeV/c. Asymmetry is slowly varying with energy while spin correlation increases considerably from 6 to 12 GeV/c. The polarized parameters in $pp \rightarrow pp$ and $pn \rightarrow pn$ elastic scattering are compared. The data show that pp and pn polarizations tend to approach mirror symmetry as the energy increases. The effective mass spectrometer has been used to study the $pp \rightarrow p\pi^+ n$, $pn \rightarrow p\pi^- p$ reactions from 2 to 6 GeV/c. For small -t values ($-t < 0.2$ GeV^2) these reactions are dominated by π exchange. At large -t values other mechanisms besides π-exchange become important. The 3-body diffraction dissociation reactions have been measured at 6 GeV/c with hydrogen and deuterium targets. The reactions are $pp \rightarrow p\pi^+ \pi^- (p)$; $pd \rightarrow p\pi^+ \pi^- (p+n)$. Comparison of hydrogen and deuterium cross section reveals a considerable coherent contribution of deuterium, which has an approximately 20% larger cross section per nucleon than hydrogen.

1724 **Pion production at high transverse momentum in 24-GeV proton-proton collisions.** Beier, E.W.; Patton, R.; Raychaudhuri, K.; Takeda, H.; Thern, R.; VanBerg, R.; Weisberg, H.; Good, M.L.; Grannis, P.D.; Johnson, K.; Kirz, J. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). *Phys. Rev., D;* **18**: No. 7, 2235-2238(1 Oct 1978).

We report measurements of the inclusive π^- and π^+ yields in 24-GeV proton-proton collisions at θ/sub c.m./ = 90° for 2.2 < or = P/sub T/ < or = 2.8 GeV/c. There is a high-P/sub T/ deficit, rather than excess, at this incident energy.

1725 **Search for six-quark states.** Carroll, A.S.; Chiang, I.; Johnson, R.A.; Kycia, T.F.; Ki, K.K.; Littenberg, L.S.; Marx, M.D.; Cester, R.; Webb, R.C.; Witherell, M.S. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **41**: No. 12, 777-780(18 Sep 1978).

We have searched the missing-mass spectrum of the reaction $pp \rightarrow K^+ K^+ X$ for a narrow six-quark resonance in the mass range 2.0—2.5 GeV/c^2. No narrow structure was observed. Upper limits for the production cross section of such a state depend upon mass and vary from 30 to 130 nb.

1726 **Polarization and angular distributions in elastic pp scattering at 100 and 300 GeV.** Snyder, J.H.; Auer, L.P.; Brueckner, W.; Chamberlain, O.; Hill, D.; Johnson, W.; Jonckheere, A.; Kline, R.V.; Koehler, P.F.M.; Law, M.E.; Pipkin, F.M.; Sandler, B.; Shapiro, G.; Steiner, H.; Underwood, D.; Yokosawa, A.; Zeller, M.E. (Yale University, New Haven, Connecticut 06520). *Phys. Rev. Lett.;* **41**: No. 12, 781-784(18 Sep 1978).

Measurements of the polarization parameter and angular distributions in pp elastic scattering at incident energies of 100 and 300 GeV are reported. The data cover the kinematic range $0.18 < -t < 2.0$ GeV^2. They are found to be consistent with absorption-model predictions.

1727 **Polarization of Λ's and Lambda-bar's produced by 400-GeV protons.** Heller, K.; Cox, P.T.; Dworkin, J.; Overseth, O.E.; Skubic, P.; Schachinger, L.; Devlin, T.; Edelman, B.; Edwards, R.T.; Bunce, G.; Handler, R.; March, R.; Martin, P.; Pondrom, L.; Sheaff, M. (Department of Physics, University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev. Lett.;* **41**: No. 9, 607-611(28 Aug 1978).

We have measured the polarization of 3 x 10^6 Λ^0 and 2.5 x 10^5 Lambda-bar^0 hyperons produced by 400-GeV protons on a beryllium target. The hyperons were detected at a fixed angle of 7.2 mrad and in the momentum range from 50 to 300 GeV/c for λ^0 and 50 to 200 GeV/c for Lambda-bar^0. The Λ^0 polarization agrees with that measured at 24 and 300 GeV and is -0.24 +- 0.04 at p/sub T/ = 2.1 GeV/c. The Lambda-bar^0 polarization is zero up to p/sub T/ = 2.1 GeV/c.

1728 **Asymmetry in elastic scattering of protons by deuterons at 630 MeV.** Murtazaev, K.; Nadezhdin, V.S.; Satarov, V.I. (Joint Institute for Nuclear Research). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 6, 316-318(20 Mar 1978).

Using a beam of polarized 630-MeV protons, we measured the asymmetry in the elastic scattering of the protons by deuterons in the c.m.s. angle interval 80° < or =rho/sub p/< or =158°. Results obtained at large angles are compared with the predictions of the resonant one-pion exchange model.

1729 **Production of deuterons and antideuterons in proton-proton collisions at the CERN ISR.** Gibson, W.M. (Bristol Univ. (UK)); Duane, A.; Newman, H.; Ogren, H. (European Organization for Nuclear Research, Geneva (Switzerland)); Henning, S.; Jarlskog, G. (Lund Univ. (Sweden)); Little, R.; Sanford, T.; Wu, S.L. (Massachusetts Inst. of Tech., Cambridge (USA)); Boggild, H. (Niels Bohr Institutet, Copenhagen (Denmark)). *Lett. Nuovo Cim.;* **21**: No. 6, 189-194(11 Feb 1978).

The inclusive production of deuterons and antideuterons at 90° in the c.m.s. has been measured at the CERN ISR. The measurements for antideuterons extend over $0.15 < p_{sub}(T) < 0.75$ GeV/c and for deuterons from 0.25 - 0.75 GeV/c for $\sqrt{s}$ = 45 and 53 GeV. In the overlapping psub(T) region average ratio d/average d = 4.1+-1.2 at both energies. The invariant cross-section for average d shows a psub(T) and energy dependence similar to those observed for average p.

1730 **Measurement of the polarization correlation coefficient C/sub n/n of elastic pp scattering at energies of 550 and 630 MeV.** Borisov, N.S.; Glonti, L.N.; Kazarinov, M.Y.; Kazarinov, Y.M.; Kiselev, Y.F.; Kiselev, V.S.; Macharashvili, G.G.; Matafonov, V.N.; Neganov, B.S.; Strakhota, I.; Trofimov, V.N.; Usov, Y.A.; Khachaturov, B.A.; Khayatov, M.R. (Joint Institute for Nuclear Research, Dubna). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 881-883(Nov 1977).

The polarization correlation coefficient C/sub n/n was determined for the elastic pp scattering at energies of 550 and 630 MeV for four scattering angles. The coefficient C/sub n/n was determined by scattering a beam of protons of 0.34—0.36 polarization by a "frozen" polarized proton target with maximum polarization of 0.98 +- 0.03. The results of the measurements indicated that, in the investigated energy range, C/sub n/n depended weakly on the angle and energy.

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 1692, 1718, 1721

1731 (ANL-HEP-PR—78-35) **Fluctuations in large-angle π^{+-} p elastic scattering.** Jenkins, K.A.; Price, L.E.; Klem, R.; Miller, R.J.; Schreiner, P.; Courant, H.; Makdisi, Y.I.; Marshak, M.L.; Peterson,

E.A.; Ruddick, K. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

An experiment was performed to search systematically for fluctuations in π^+ p elastic scattering from 2 to 6.3 GeV/c and π^- p from 2 to 9.7 GeV/c. Differential cross sections are plotted. Three references. (JFP)

1732 (COO—1428-449) **Status of baryonium experiments.** Miller, D.H. (Purdue Univ., Lafayette, IN (USA)). 1978. Contract EY-76-C-02-1428. 10p. (CONF-780338—7). Dep. NTIS, PC A02/MF A01.

From 3. conference on new results in high energy physics; Nashville, TN, USA (6 Mar 1978).

The experimental evidence for resonant states coupled to the baryon—antibaryon system is reviewed. The evidence for broad states known as the S(1963), T(2190) and U(2350) is compelling, however, there is no evidence for I = 2 states and the observation of narrow states needs confirmation.

1733 (COO—1545-237) **Charge—exchange production of axial vector mesons at 8.45 GeV/c.** Edwards, K.W.; Legacey, D.; Brockman, P. (Carleton Univ., Ottawa, Ontario (Canada). Dept. of Physics; McGill Univ., Montreal, Quebec (Canada). Dept. of Physics; Ohio State Univ., Columbus (USA). Dept. of Physics; Toronto Univ., Ontario (Canada). Dept. of Physics). 1978. Contract EY-76-C-02-1545. 15p. (CONF-780826—3). Dep. NTIS, PC A02/MF A01.

From 19. conference on high energy physics; Tokyo, Japan (23 Aug 1978).

Differential cross sections are presented for the reactions π^- p $\rightarrow$ B^0(1235)n, $B^0 \rightarrow \omega^0\pi^0$ ($\omega^0 \rightarrow \pi^+\pi^-\pi^0$), and π^- p $\rightarrow$ D^0(1285)n, $D^0 \rightarrow$ eta$^0\pi^+\pi^-$ (eta$^0 \rightarrow \gamma\gamma$) at 8.45 GeV/c. The data were obtained at the Argonne ZGS with the Charged and Neutral Spectrometer which detected both charged pions and all γ rays in these final states.

1734 (JINR-D—1,2-10400, pp C19-C21) **New phenomena in the Q-region.** Otter, G. (Technische Hochschule Aachen (Germany, F.R.)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The Q-mass region has been studied by two high-statistics experiments which have allowed a partial-wave analysis (PWA) to be performed in small (K$\pi\pi$)-mass intervals. The experiments were carried out by the SLAC spectrometer group who investigated the diffractive reactions of K^- p $\rightarrow$ $K^-\pi^+\pi^-$p, K^+ p $\rightarrow$ $K^+\pi^+\pi^-$p and also in a bubble chamber with combination of data from the reactions of K^- p $\rightarrow$ $K^-\pi^+\pi^-$ p, K^-p $\rightarrow$ anti $K^0\pi^-\pi^0$p. The PWA results for various reactions considered agree essentially. There exists good evidence for at least one strangeness-1 resonance which decays mainly into Krho and which is produced by a different mechanism from that of the other states. Its mass was in the approximately 1300 MeV range. To search for other decay modes of this resonance the low mass Kω-system was investigated. It shows a peak near threshold which is produced diffractively in the same way as the K rho spectrum. Another interesting result concerning the (K$\pi\pi$) system is given. The existence of a new strangeness-1 resonance is reported. The resonance parameters are: M approximately = 1400 MeV, W approximately = 250 MeV.

1735 (JINR-D—1,2-10400, pp A2-13-A2-15) **Associated correlation effects in π^-p interactions at 40 GeV/c.** Abesalashvili, L.N.; Amaglobeli, N.S.; Koutsidi, N.K.; Makharadze, T.G.; Salukvadze, R.G.; Slepchenko, L.A.; Thevzadze, Yu.V.; Chargeishvili, M.S. (Tbilisskij Gosudarstvennyj Univ. (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Results of an experimental study of semiinclusive π^-p interactions at 40 GeV/c are presented. The work has been done within the frame work of the 2-m JINR propane bubble chamber international collaboration. The results are based on the analysis of approximately 10400 inelastic interactions. The distribution at an associated multiplicity as a function of transverse momentum of trigger π^{+-} meson from reaction π^- p$\rightarrow\pi^{+-}$ +(n-1)ch+... is presented. A weak dependence of the associated multiplicity on transverse momentum psub(tr) is seen for low psub(tr) range whereas it is nearly constant for higher psub(tr). The dependence of the average transverse momentum of associated particles on the value of psub(tr) of the trigger particle is studied too. Data show an increase in the (psub(tr))sub(ass) with the increase in the psub(trtrig) value.

1736 (JINR-D—1,2-10400, pp C26-C27) **Search for exotic mesons $X^{--}\rightarrow$p anti p$\pi^-\pi^-$ in the C.E.R.N. Omega spectrometer.** 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

In the experiment a search has been made for exotic X^{--} mesons in the reaction of π^- n$\rightarrow$P/sub forward/+X^{--} (X^{--} decaying into p anti p$\pi^-\pi^-$ with a 12-GeV/c beam. The experimental layout is the same as in the Omega-fast proton experiment. The 60 cm length target has been filled with deuterium. The upper limits for the production of narrow X^{--} resonances are set.

1737 (JINR-D—1,2-10400, pp A1.14-A1.17) **Baryon exchange in 12 GeV/c π^- p interactions.** Arenton, M.W.; Bacino, W.J.; Hauptman, J.M. (California Univ., Los Angeles (USA)); Shepard, P.F. (Pittsburgh Univ., Pa. (USA)); Gearhart, R.A. (Stanford Linear Accelerator Center, Calif. (USA)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Preliminary results are reported on the production of boson states B^0 by baryon exchange in reactions of the type π^- p$\rightarrow$nB^0 at an incident momentum of 12 GeV/c. Experiment has been carried out by photographing the SLAC 40" hydrogen bubble chamber operating in its rapid cycling mode on detection of energetic forward neutrons. The most fully analyzed data concern the reaction π^- p$\rightarrow$n$\pi^-\pi^+$. These results are compared with other experiments at different energies.

1738 (JINR-D—1,2-10400, pp A2.21-A2.26) **Recent results on 32 GeV/c K^{+-}p and anti pp interactions in the Mirabelle bubble chamber.** Barloutaud, R. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

This report is a summary of the recent results obtained by the France-Soviet Union and CERN-Soviet Union Collaborations with the 4.6-m Mirabelle hydrogen bubble chamber exposed at the Serpukhov accelerator to separated K^+, K^- and anti p beams at 32 GeV/c. These results are based on the analysis of 100 K, 80K and 12 K pictures of K^+, K^- and anti p experiments, respectively. The data are presented together to allow a useful comparison between the K^+ p, K^- p and anti pp interactions. The π^0 average multiplicity is almost identical in three experiments (1.89 +- 0.05), (1.96+-0.05) and (1.80 +-0.15) for K^+ p, K^- p and anti pp interactions respectively. The average multiplicity of π^+ and π^- are found to be quite compatible with the π^0 multiplicity. The inclusive cross sections for the reactions A + p $\rightarrow$ K/sup n/ + x are (7.6 +-0.2), (9.8+-0.25) and (6.3+-0.6) mb for A = K^+, K^- and anti p respectively. The inclusive production cross section for Δ (and epsilon ^{0}) amounts to (0.8+-0.08), (2.35+-0.08) and (1.7+-0.3) mb in K^+ p, K^- p and anti pp interactions, respectively. Results on the total and differential cross sections of K^- p elastic scattering are presented. The cross sections of reactions A p $\rightarrow$ A p + n ($\pi^+ + \pi^-$) where A = K^+, K^-, anti p have been measured. The energy dependence of the four-body reactions shows a steeper decrease for K^+ and anti p incident particles than for K^-. For K^+, K^-, anti p reactions the plot of π^+ rapidity versus π^- rapidity is for presenting of clustering effects in the four-body reactions.

1739 (JINR-D—1,2-10400, pp C42-C44) **Ω and Ξ^* production in K^-p interaction.** Barloutaud, R. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Data of three experiments are reviewd. The first one deals with the Ω^- production studied in K^-p interactions at 4.2 GeV/c in 2-meter hydrogen bubble chamber. The main results, based on 32 events decaying into ΛK^-(23), $\Xi^0\pi^-$(7) and $\Xi^-\pi^0$(2), are given. The results of Ξ^* production in the two-body reaction K^-p$\rightarrow\Xi^{*-}K^*$ are presented. The Ξ^* production is shown followed by the decay of the Ξ^* into ΛK^-, Σ^0K^- or Σ^-K^- $\Xi^-\pi^0$ and $\Xi^-\pi^+\pi^-$. Three significant peaks have been found in various mass distributions. A search for Ξ^* resonance is reported also in the K^-p interactions at 14.3 GeV/c. At this incident momentum the Ξsup(*) production in two-body reactions is so low that there is no hope to find them in a bubble chamber experiment. An inclusive search has been carried out in the following reactions: K^-p$\rightarrow\Xi^-\pi^+$anything; K^-p$\rightarrow\Xi^{*0}\pi^-$+anything; K^-p$\rightarrow\Xi^-\pi^+\pi^-$+anything; K^-p$\rightarrow$YK^-+anything. The inclusive mass distributions of the various mass combinations $\Xi^-\pi^+$, $\Xi^-\pi^+\pi^-$, YK^- show some structures which are more or less significant.

1740 (JINR-D—1,2-10400, pp C27-C30) **Nucleon polarization in the $\pi^- p \to n\pi^+\pi^-$ reaction.** Becker, H.; Blum, W.; Chabaud, V. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Preliminary results from a high-statistics measurement of the $\pi^- p \to n \pi^+ \pi^-$ reaction on a polarized target at 17.2 GeV show unexpectedly strong nucleon polarization effects. If these are due to the exchange of an additional particle, this object has the quantum number of the A_1. Possibly, it can also be explained (similarly to the helicity-one moments in one pion exchange) by final-state interaction. The problem is of particular interest for $\pi\pi$ scattering as A_1 exchange has been assumed to be absent in all $\pi\pi$ phase-shift analyses. A continuation of the unfinished analysis will hopefully clarify the situation.

1741 (JINR-D—1,2-10400, pp A2-34-A2-37) **Inclusive π^0 and γ production in pion-proton interaction at 5 GeV.** Budagov, Yu.A.; Sandor, L. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

One-meter JINR propane bubble chamber collaboration studied the inclusive neutral particle production (π^0,γ) in the 5-GeV pion-nucleon interaction. The π^0 multiplicity at 5 GeV was close to the Poisson form. The correlations in the yields of π^0 were analyzed and the correlation integrals as a function of incident momentum were represented. The differential cross section for the reaction $\pi^- p \to \gamma + ...$ at 5 GeV/c was measured in a large range of transverse momenta using the statistics of approximately 10000 γ-quanta.

1742 (JINR-D—1,2-10400, pp A2-39-A2-41) **Search for new neutral particles produced in highly inelastic π^+ proton collisions at 10.5 GeV/c.** Elliott, J.R.; Fortney, L.R.; Goshaw, A.T.; Lamsa, J.W.; Loos, J.S.; Robertson, W.J.; Walker, W.D.; Yeager, W.M. (Duke Univ., Durham, N.C. (USA). Dept. of Physics); Sun, C.R.; Dhar, S. (State Univ. of New York, Albany (USA). Dept. of Physics). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Authors have done an experiment which makes an analysis of the neutral-particle spectrum coming from 10.5-GeV/c $\pi^+ p$ interactions in which a large fraction of the available energy goes into neutrals. The experiment is designed to determine if all the energy carried away by neutral particles can be accounted for by photons K^0's, and Λ^0's, and neutrons. The data are taken from an exposure of the SLAC 82" bubble chamber filled with a hydrogen-neon mixture (30 molar percent neon) and exposed to a 10.5 GeV/c π^+ beam. The experiment proves that the neutral particle spectrum can be explained in terms of the above mentioned particles. Any additional neutral particles produced carry less than 5% of the available momentum.

1743 (JINR-D—1,2-10400, pp C1-C4) **Delta(970) resonance and other 0^+ effects.** Holmgren, S.O. (European Organization for Nuclear Research, Geneva (Switzerland)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Many experimental and theoretical efforts have been devoted to the understanding of 0^+ resonances during at least 10 years. The establishment of these states is complicated by very drastic threshold effects, and in a critical examination it is possible to cast some doubts on each of them. The evidence for delta-970 comes from production experiments. New experimental information supports the existense of delta-970 compatible with SU-3 predicted coupling to K anti K. However, the possibility that the small width may be caused by a wide object with strong K anti K coupling has been pointed out. A possible new 0^+ resonance is reported. The confirmation and settlement of its isospin assignment is urgent.

1744 (JINR-D—1,2-10400, pp C40-C42) **Production of baryon resonances in $K^- p$ interactions at 4.2 GeV/c.** Kittel, W. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The production of $\Sigma(1660)$ and of a $p\omega$ enhancement in $K^- p$ interaction at 4.2 GeV/c is reported. The reaction of $K^- p \to \Sigma^+(1660)\pi^-$ was studied in 65 event/mb sample of $\Sigma\pi\pi(\pi)$, $\Lambda\pi\pi(\pi)$ and p antiK$^0\pi^-$ final states. The $\Sigma(1660)$ produced in the decay mode $\Sigma\pi$ differs greatly in its production angular distribution from that in the $\Lambda\pi$ mode. The reaction of $K^- p \to K^-$ rhoω was studied in the $K^-\pi^+\pi^0 p$ final state with a sample of 21 event/mb. A rhoω enhancement of mass of 1815 MeV and width about 125 MeV is observed. This enhancement is produced peripherally with no significant anisotropy in its decay.

1745 (JINR-D—1,2-10400, pp C89-C90) **Final states of $K^- N$ reactions.** Kittel, W. (Katholieke Universiteit Nijmegen (Netherlands)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

A good statistical formation measurement of the $K^- n$ cross section in the energy range of 1750-2200 MeV is given. The $K^- d \to p\Lambda\pi^-$ shows a sharp fall between 1750 and 1950 MeV and has a bump around 2000 MeV. The $K^- n \to \Sigma^0\pi^0$ cross sections fall between 1750 and 2000 MeV and have indication for a maximum at 2100 MeV. The isospin inelastic scattering cross section is determined from the reaction of $K^- p \to \Delta^{++}$ at 4.2 GeV/c incident K^- momentum. Spin-parity content and production mechanism of $(\pi^+\pi^-)$ systems in the $\pi^+ p \to (\pi^+\pi^-)\Delta^{++}$ reaction at 16 GeV/c are studied as functions of the $(\pi\pi)$mass and of the four-momentum transfer. Transversality amplitudes and spin density matrix elements for the similar Ksup(-)p→(πsup(+)πsup(-))sub(s wave)Σsup(0)(1385) process are determined from an amplitude analysis. A partial wave analysis of the low-mass $(\pi^+\pi^- p)$ system produced in the $K^- p \to K^-(\pi^+\pi^- p)$ reaction at 4.2 GeV/c shows that the low-mass $(\pi^+\pi^- p)$ system can be described using the spin-parity states. A so-called "multi-channel" analysis considering simultaneously all contributions to a final state in full dimensional phase shift has been applied to the $K^- p \to$ antiK$^0\pi^- p$ reaction at 42.8 GeV/c.

1746 (JINR-D—1,2-10400, pp C45-C82) **Meson and baryon spectroscopy.** Lanius, K. (Akademie der Wissenschaften der DDR, Berlin-Zeuthen. Inst. fuer Hochenergiephysik). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Some of the essential results of hadron spectroscopy which have been obtained in the last two years are given. The progress in meson spectroscopy originates in high statistics and in the extensive use of partial-wave analysis. The resonances established fill the major meson multiplets. The rotational excitation (α)=0 multiplet is complete. With regard to the gaps in the 1^{++} and 1^{+-} nonets of the α=1 multiplet there are some good condidates, like $Q_2(1400)$ and D(1285). Concerning the α=2 and 3 multiplets, there are only very few established states. The reactions that should be studied in searching for the missing states are exclusive channels with multiparticle final state. Both the new evidence about meson resonances and the non-evidence for exotic states, which cannot be represented as a bound q anti q pair, show that the general pattern of meson states is in agreement with the naive nonrelativistic quark model. The summary of SU(6)xO(3) multiplets, as far as it belongs to the distribution of the observed resonances among the different multiplets, can be changed in future. Only the $[56.0^+]$ can be considered as well established concerning the distribution of the states. As for the $[56.1^-]$, $[70.2^+]$ and the second $[56.2^+]$, additional confirmations are necessary.

1747 (JINR-D—1,2-10400, pp C11-C14) **A_1 meson problem.** Markytan, A. (Oesterreichische Akademie der Wissenschaften, Vienna. Inst. fuer Hochenergiephysik). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The A_1 is currently seen as a threshold enhancement of the $(\text{rho}^0\pi^{+-})$ system in the $\pi^{+-} p \to \text{rho}^0\pi^{+-} p$ reactions. It is produced diffractively, and its production mechanism can be well explained by the Deck model, which implies the A_1 not being a resonance. In cluster analyses the A_1 is found to be a low-mass cluster which is characterized by the strong pion exchange coupling within the $(3\pi)^{+-}$ systems. The A_1 has not been seen in charge exchange reactions and annihilation-type reactions.

1748 (JINR-D—1,2-10400, pp C4-C7) **eta'(958) spin-parity problem.** Ogievetsky, V.I. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The present status of the eta'(958) spin-parity problem is elucidated. The Dalitz plot analysis of eta' → eta $\pi\pi$ and eta' → $\pi\pi\gamma$ does not distinguish between 0^- and 2^-. All the data are consistent with the 2^- hypothesis. The only way to establish the eta' spin is to

study production-decay correlations. However, for 2^- these correlations can be masked in a wide region of the production angle. All three one-dimensional correlations observed agree with 2^- predictions. The correlations are valid only at transverse momentum < = 100 MeV/c, but the statistics are poor. One can confirm or not confirm these correlations only by using the same (or more severe) cut in transverse momentum. It is concluded that the eta'-spin problem remains unsolved.

1749 (JINR-D—1,2-10400, pp A2.37-A2.39) **Net charge distribution in rapidity and transverse momentum for semi-inclusive π^-p interactions at 11.2 GeV/c.** Ratti, S.P.; Attendoli, R.; Calligarich, E. (Istituto Nazionale di Fisica Nucleare, Pavia (Italy)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Authors present an analysis of the net charge density distributions in π^-p collisions at 11.2 GeV/c, studying how electric charge gets distributed for different topologies as a function of rapidity and transverse momentum. The experimental data have been collected in an approximately 850,000-picture exposure of the CERN 2m hydrogen bubble chamber to a π^- beam of 11.2 GeV/c. The structures of charge density distributions are complex and an appealing explanation is the leading particle effect and/or diffraction dissociation present in two and four prongs, but not in six prongs.

1750 (JINR-D—1,2-10400, pp A2.9-A2.12) **Inclusive particle and resonance production.** Schmid, P. (European Organization for Nuclear Research, Geneva (Switzerland)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The paper summarizes work on inclusive resonance production. It is based on about 1.1 million events coming from the following bubble chamber experiments: π^+p at 8, 16 and 23 GeV/c, π^-p at 16 GeV/c and K^-p at 10 and 16 GeV/c. The resonances rho^0, f, eta, ω, K*-890, K*-1420, Δ^{++} and Σ^{+-}-1385 are studied. Results are presented on separation of fragmentation and central production of secondary particles; universality of transverse momentum spectra; direct particle production and contribution from resonance decays.

1751 (JINR-D—1,2-10400, pp C7-C10) **Recent results on the anti KK system and on rho-ω interference.** Wicklund, A.B. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

A high statistics study of K^-K^+ production at 6 GeV/c in the reactions of π^- p → K^-K^+n, π^+ n → K^-K^+ p has been carried out. These reactions are related to anti K^0K^0 final state by charge symmetry. Experiments indicate a large anti K K S-wave cross section with a possible resonant enhancement under the f(1270). The data have revealed new phenomena such as f'(1514) → π π, f-f' and f-$A_2{}^0$ interference. Previously observed phenomena such as rho - ω interference have been measured better, such measurement allowing detailed tests of symmetry predictions for production amplitudes.

1752 **πpp charge-exchange amplitude zeros from a Barrelet analysis between 1.4 and 2.3 GeV.** Chew, D.M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., D;* **18**: No. 7, 2368-2386(1 Oct 1978).

Using the available scattering and polarization pion-nucleon charge-exchange data, we have performed a Barrelet-moment analysis between 1.4 and 2.3 GeV. The method allows us to identify and discard data with important systematic error. Above 1.5 GeV, ten zeros are unambiguously required in order to represent the retained data. An attempt is made to resolve the discrete ambiguity and to obtain the location of amplitude zeros close to the physical region.

1753 **Test of the Okubo-Zweig-Iizuka rule in phi production.** Etkin, A.; Foley, K.J.; Goldman, J.H.; Love, W.A.; Morris, T.W.; Ozaki, S.; Platner, E.D.; Saulys, A.C.; Wheeler, C.D.; Willen, E.H.; Lindenbaum, S.J.; Kramer, M. Mallik, U. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **41**: No. 12, 784-787(18 Sep 1978).

We1.4have measured the reaction π^-p → $K^+K^-K^+K^-$n at 22.6 GeV/c and defect strong phi signals in the K^+K^- effective-mass plots. We do not observe the expected Okubo-Zweig-Iizuka—rule suppression of the phiphin final state and conclude that the rule is working poorly in the observed production processes.

1754 **Confirmation of exchange-degeneracy predictions in the line-reversed reactions: π^-p → K^-Y* (1385) and K^-p → π^-Y* (1385) at 11.5 GeV/c.** Ballam, J.; Bouchez, J.; Carroll, J.T.; Cautis, C.V.; Chadwick, G.B.; Chaloupka, V.; Field, R.C.; Freytag, D.R.; Lewis, R.A.; Minard, M.N.; Moffeit, K.C.; Stevens, R.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **41**: No. 10, 676-679(4 Sep 1978).

We have measured in a single experimental setup the differential cross sections and polarizations of the Y* (1385) produced in the two line-reversed reactions π^+p → K^+Y* (1385) (260 eV/μb) and K^-p → π^-Y* (1385) (180 eV/μb) at 11.5 GeV/c. We compare these results to Σ^+ production in the same experiment. The data have been derived from a triggered bubble-chamber experiment using the SLAC Hybrid Facility. We find that both helicity-flip—dominated (Y*) and helicity-nonflip—dominated (Σ) processes are consistent with weak—exchange-degeneracy predictions.

1755 **Correlations between secondary particles in π^-A interaction at 3.7 GeV/c.** Gavrilov, V.B.; Degtyarenkov, P.V.; Efremenko, V.I.; Zaitsev, Y.M.; Leksin, G.A.; Suchkov, D.A. (Institute of Theoretical and Experimental Physics). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 6, 348-352(20 Mar 1978).

Correlations are investigated between π^- mesons emitted backwards in π^-A interactions at 3.7 GeV/c, on the one hand, and the fast positive particles traveling forward. It is observed that the correlation parameter R is independent of either the energy of the backward emitted π^- meson or of the momentum of the forward-moving particle.

1756 **Diffraction dissociation of the proton into ΛK^+ and $(\Sigma K)^+$ in π^+p interactions at 10.3 GeV/c.** Goddard, M.C.; Key, A.W. (Toronto Univ., Ontario (Canada). Dept. of Physics); Gordon, H.A.; Lai, K.W. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Phys., B;* **134**: No. 1, 49-60(6 Mar 1978).

A threshold ΛK^+ enhancement is observed in the reaction π^+p→$\Lambda K^+\pi^+$ at 10.3 GeV/c. The production characteristics are very similar to those of the diffractive ΛK^+ enhancement observed at the CERN ISR. The $\Sigma K\pi$ channels show no similar $(\Sigma K)^+$ ehancement, as predicted by SU(6).

1757 **A-dependence of the inclusive distributions of the J/psi particles.** Antipov, Y.M.; Bezzubov, V.A.; Budanov, N.P.; Gorin, Y.P.; Denisov, S.P.; Ech, F.A.; Klimenko, S.V.; Lebedev, A.A.; Mikhailov, Y.V.; Petrukhin, A.I.; Polovnikov, S.A.; Roinishvili, V.N.; Stoyanova, D.A. (Institute of High Energy Physics). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 291-294(5 Mar 1978).

We measured the differential cross sections dσ/dx and dσ/dp^{2}t-italic/sub oftheinclusiveproductionofJ//psi particles by π^- mesons with momentum 43 GeV/c from the nuclei Be, Cu, and W. The dependence of the cross sections on the atomic weight A of the nucleus was approximated by the function A/sup α/. The exponent α increases with increasing p/sub t/^{2} and is independent of x within the limits of statistical errors.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

1758 (JINR-D—1,2-10400, pp A3-19-A3-23) **Correlations in multiple production and clusters.** Thomas, G.H. (Argonne National Lab., Ill. (USA)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The Mueller-Regge model description of $\pi^+\pi^-$ correlations and fraction of the $\pi^+\pi^-$ correlation due to the Bose-Einstein statistics is considered. The dipion mass is used as one of the variables of the correlation function. The difference in the $\pi^-\pi^-$ and $\pi^+\pi^-$ threshold behavior is discussed. The mass variable is very useful for studying questions about the Mueller amplitudes and for studying coherent interference effects which are expected near threshold.

1759 **Quantum chromodynamics and the solition model of hadrons.** Friedberg, R.; Lee, T.D. (Barnard College and Columbia University, New York, New York 10027). *Phys. Rev., D;* **18**: No. 7, 2623-2631(1 Oct 1978).

By starting from quantum chromodynamics (QCD) in a finite volume and then taking the infinite-volume limit, we suggest that there is a "phase-transition" phenomenon, which implies the existence of a long-range order in the vacuum for an infinite volume. This long-range order is represented by Lorentz scalars, because of relativistic invariance; such Lorentz scalars can in turn be identified with the phenomenological scalar fields used in a soliton (or bag) model of hadrons. In the phenomenological approach, a permanent quark confinement can be simply viewed as the vacuum of an infinite volume being a perfect "dia-electric" substance, with its dielectric constant $\kappa \to 0$, while the "vacuum" inside a hadron is normal (κ =

1), which may be identified as that of QCD for a finite volume. Inside the hadron, exchanges of gauge quanta between quarks give the QCD corrections to the soliton (or bag) model. Spectroscopy of light-quark hadrons is examined by expanding the hadron masses M in powers of the "fine-structure constant" α of QCD: $M = M_0 + \alpha M_1 + \alpha^2 M_2 + \ldots$. The near-zero mass of the pion is correlated with the existence of a critical value α/sub c/ in the mass formula, and the eta-eta' anomaly is associated with a large enhancement factor in the O (α^2) quark-antiquark annihilation diagrams, due to coherence in the various color and flavor degrees of freedom.

1760 Angular crossing relations and Euclidean approximation in the unitarization of the isobar model. Brehm, J.J. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003). *Phys. Rev., D;* **18**: No. 7, 2718-2720(1 Oct 1978).

The previous derived subenergy discontinuities of isobar amplitudes are manipulated into a concise form in which the dependence on all the angle is rather transparent. An approximation, suitable at low energy, called the Euclidean approximation is described.

1761 Gluon jets from quantum chromodynamics. Shizuya, K.; Tye, S.H. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.;* **41**: No. 12, 787-791(18 Sep 1978).

Following the idea of Sterman and Weinberg, we calculate the jet angular radius of a gluon jet and its energy dependence in the framework of pertrubative quantum chromodynamics. The result is free of infrared and mass singularities and does not depend on the gluon fragmentation function. We find that the gluon jet spreads much more (i.e., less jetlike) than a quark jet; this renders the detection of gluon jets very difficult.

1762 Is the up-quark mass zero. Deshpande, N.G.; Soper, D.E. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon, 97403). *Phys. Rev. Lett.;* **41**: No. 11, 735-738(11 Sep 1978).

We consider, within the framework of current algebra, the possibility that the up-quark mass vanishes (as an alternative to the axion). We argue that the contrary current-algebra value, m/sub u// m/sub d/ = 1/1.8, is unreliable. A critical analysis leads to the conclusion that m/sub u/ = 0 is not unreasonable and furthermore leads to a surprisingly good prediction for the δ-meson mass.

ELECTROMAGNETIC INTERACTIONS

1763 (JINR-D—1,2-10400, pp A3-10-A3-12) **Many-component description of inclusive and semi-inclusive processes.** Sissakian, A.N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

A hypothesis that secondaries are not of the same origin, but are produced due to two or more different mechanisms, is an interesting idea in phenomenology of multiparticle production. The schemes and models based on the hypothesis are called the many-component description. The first effort to combine two extreme approaches proceeds from the fact that the production of secondaries is due to the fragmentation of the colliding objects. The second one is based on the idea of independent emission of particles or their definite associations (clusters, resonances, etc.). Different realizations of the multicomponent description have been proposed. The two-component model is one of the clearest realizations of the idea. This idea can be realized also by using the phenomenological model of two mechanisms (the model of two mechanisms). The many-component representation becoms highly useful when analyzing the inclusive distributions in the process of e^+e^-→hadrons.

1764 (JINR-D—1,2-10400, pp A7-11-A7-14) **Phenomenological analysis and the models of the electromagnetic form factors of hadrons.** Skachkov, N.B. 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The electromagnetic form factors of hadrons are analyzed from the viewpoint of vector dominance and quark models. According to the estimate by these models, the relative motion of three quarks constituting a proton is within the region of the Compton proton wave length order. Consequently, they produce the contribution of the central part of a proton, while the quark-antiquark pairs compose the vector mesons. Also the problems of description of electromagnetic form factors of hadrons in the framework of the dispersion approach on the basis of strong interaction data are discussed.

1765 Charmed-particle production in hadronic and electromagnetic processes. Goldhaber, M.; Wang, L. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **18**: No. 7, 2364-2367(1 Oct 1978).

Cross sections for the production of charmed particles in hadronic and electromagnetic interactions with hadrons are estimated in various energy regimes. Some implications of the results are discussed.

1766 Search for the A_1 in tau → ν/sub tau/rhoπ. Geffen, D.A.; Wilson, W.J. (University of Minnesota, School of Physics and Astronomy, Minneapolis, Minnesota 55455). *Phys. Rev., D;* **18**: No. 7, 2488-2494(1 Oct 1978).

Within the context of current algebra, we analyze the possibility of observing the elusive A_1 meson (J/sup P/C = 1^{++}) in the heavy-lepton decay $tau^{+-} \rightarrow \nu$/sub tau/$rho^0\pi^{+-}$. In our model the form factors for the decay amplitude are then completely determined in terms of the A_1 mass and width so that we are able to predict both the branching ratio and rhoπ mass spectrum for this decay. We find that the data are compatible with a wide range of A_1 parameters including the possibility that there is no A_1 contribution at all to this decay mode. Only a modest increase in experimental precision, however, would provide a stringent test of the current-algebra model and, if successful, yield an accurate determination of the parameters of the A_1.

1767 M1 transitions in the MIT bag model. Hackman, R.H.; Deshpande, N.G.; Dicus, D.A.; Teplitz, V.L. (Hollins College, Roanoke, Virginia). *Phys. Rev., D;* **18**: No. 7, 2537-2546(1 Oct 1978).

We investigate, in the MIT bag model, the M1 transitions of low-lying hadrons. We perform the following calculations: (1) We recompute 32 hadron masses with a choice of bag parameters designed to give the correct values for the proton magnetic moment, μ/sub p/, and several masses, M/sub rho/, M/sub ω/, M/sub Δ/, M/sub Ω/, and M/sub D/; (2) we compute eta, eta', eta/sub c/ mixing in an untrustworthy approximation; and (3) we compute the widths for 38 M1 transitions.

1768 Hyperon magnetic moments in SU(3). Bohm, A. (Center for Particle Theory, University of Texas, Austin, Texas 78712). *Phys. Rev., D;* **18**: No. 7, 2547-2552(1 Oct 1978).

The hyperon magnetic moments and the magnetic transition moment μ/sub $\Sigma^0\Lambda$ have been calculated under various assumptions for the electromagnetic current operator within the spectrum-generating SU(3) approach. None of these assumptions, including the conventional ones using the Gell-Mann—Nishijima formula and SU(3) symmetry, lead to an acceptable fit to the experimental data.

1769 Production of large-transverse-momentum jets in photon-photon collisions. Brodsky, S.J.; DeGrand, T.A.; Gunion, J.F.; Weis, J.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **41**: No. 10, 672-676(4 Sep 1978).

We predict a new source of jet structure in e^+e^- colliding-beam experiments arising from photon-photon collisions. These jets are produced with a sizable fraction of the total observable hadronic rate and have unmistakable signatures. Observations of these jets would provide important tests of the contributions of three classes of hard-scattering mechanisms: quark exchange in $\gamma\gamma \rightarrow$ qq-bar, gluon exchange in qq and qq-bar scattering, and constituent-interchange processes with a characteristic p/sub perpendicular/$^{-6}$ behavior.

1770 Unified approach to jet processes in quantum chromodynamics. Kazama, Y.; Yao, Y. (Physics Department, University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev. Lett.;* **41**: No. 9, 611-614(28 Aug 1978).

We have analyzed in the leading-logarithm approximation a closed set of equations, the solution of which describes correctly the processes $e^+ + e^- \rightarrow$ anything, $e^+h \rightarrow e +$ anything, and $e^+ + e^- \rightarrow h +$ anything. This approach allows us to justify clearly the application of the renormalization group and the so-called factorization property. Since the technique is basically a skeleton expansion, it should be useful to give a unified description of all jet processes.

WEAK INTERACTIONS

1771 Single-pion production by the weak neutral current. Monsay, E.H. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **18**: No. 7, 2277-2289(1 Oct 1978).

We investigate gauge-theory-model predictions for various aspects of single-pion production by the weak neutral current. The models investigated are representatives of SU(2) x U(1) SU(2) x SU(2) x U(1), and SU(3) x U(1) type gauge theories. Adler's model for single-pion production, including all $l = 0$ and $l = 1$ multipoles, is used. Corrections for scattering off nuclear targets are evaluated in a model by Adler, Nussinov, and Paschos. Comparison is made with the available data.

1772 Role of gluons in the neutrino production of charm. Babcock, J.; Sivers, D. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **18**: No. 7, 2301-2307(1 Oct 1978).

We suggest that a sensible and consistent way of treating the associated production of charm and strangeness in νN or nu-barN collisions is to consider the basic subprocess to be $W^+ V \rightarrow$ cs-bar or $W^- V \rightarrow$ scm, respectively, where W is the virtual weak gauge boson and V denotes a colored gluon. An explicit calculation illustrates how the concept of the sea in the parton model can turn out to be process dependent in the sense that relative amounts of charm and strangeness in the sea of a nucleon as inferred from neutrino data need not be the same as those inferred from electroproduction data.

1773 Higgs bosons in a left-right—symmetric gauge model. Grifols, J.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **18**: No. 7, 2704-2707(1 Oct 1978).

In the framework of an SU(2)/sub L/ x SU(2)/sub R/ x U(1) gauge model we construct a Higgs sector where some of the scalars have large couplings to the fermions. We discuss the limits on the strength of the couplings imposed by weak-interaction phenomenology. Rough estimates for the decay rates of vector mesons into Higgs particles are given.

1774 Remarks on single-pion production by the weak neutral current. Monsay, E.H. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **41**: No. 11, 728-731(11 Sep 1978).

I compare gauge-theory—model predictions for exclusive pion production by the weak neutral current, incorporating corrections for scattering off nuclear targets where appropriate, with all the available data. I find that, based on these data, no model should be completely ruled out.

1775 Determining the neutrino-hadron weak neutral-current couplings. Sidhu, D.P.; Langacker, P. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **41**: No. 11, 732-735(11 Sep 1978).

It has been argued recently that the inclusive, semi-inclusive, and elastic neutrino-hadron data require the neutral-current parameters to lie in one of two allowed regions in coupling-parameter space (called regions A and B). We remark in this paper that new measurements of ν (nu-bar) p $\rightarrow \nu$ (nu-bar) p strongly favor region A [which corresponds to the standard SU(2)/sub L/ x U(1) and SU(2)/sub L/ x SU(2)/sub R/ x U(1) models] over region B [which corresponds to an SU(2) x U(1) model with a (μ,b)/sub R/ doublet and d/sub R/ singlet]. Neutral-current couplings of u and d quarks determined by this analysis are given.

1776 New upper limit for $\mu \rightarrow e\gamma\gamma$. Bowman, J.D.; Cheng, T.P.; Li, L.; Matis, H.S. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **41**: No. 7, 442-445(14 Aug 1978).

The different decay rates of $\mu \rightarrow e\gamma\gamma$ for the most general local interaction are presented. It is shown that recently publishing data on $\mu \rightarrow e\gamma$ imply an upper limit on the branching ratio for $\mu \rightarrow e\gamma\gamma$ of 5×10^{-9} with 90% confidence. This is almost two orders of magnitude better than the existing experimental limit. Gauge models which allow a larger rate for $\mu \rightarrow e\gamma$ are discussed.

1777 $\mu \rightarrow e\gamma$: possible signature of heavy neutral leptons. Barger, V.; Nanopoulos, D.V. (Wisconsin Univ., Madison (USA). Dept. of Physics). *Nuovo Cim., A;* **44**: No. 2, 303-317(21 Mar 1978).

The rare decay modes $\mu \rightarrow e\gamma$, $K^+ \rightarrow \pi^+ \mu e$ and Ksub(L)$\rightarrow \mu e$ are calculated in a model in which two heavy neutral leptons (Msup(deg), Esup(deg)) have right-hand couplings to both muons and electrons. For msub(E)=0.5 and msub(M)=2.0GeV it is found that. ($\mu \rightarrow e\gamma$)=1.3.10^{-9}delta^2, B($K^+ \rightarrow \pi^+ \mu^+ e^-$)=5.8.$10^{-14}$delta^2 and B(Ksub(L)$\rightarrow \mu^+ e^-$))=4.8.$10^{-12}$delta^2, where delta=sin 2ω specifies the Esup(deg), Msup(deg) mixing. It is verified that present limits on μe universality are not violated. Expected production and decay characteristics of the new leptons are presented and experimental possibilities for observation of gross electron and muon number violations are discussed.

1778 Check on the heavy-lepton hypothesis by means of the hadron spectra of the reaction $e^+ e^- \rightarrow L^+ L^-$. Berkov, A.V.; Zhizhin, E.D.; Nikitin, Y.P.; Khoze, V.A. (Moscow Engineering Physics Institute). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 864-871(Nov 1977).

Exact expressions are obtained for the hadron spectra of few-particle decays of the heavy leptons L^{--} produced in the reaction $e^+ e^- \rightarrow L^+ L^-$. The possibility of verifying the hypothetical existence of heavy leptons are discussed and the values of their parameters are established in a study of the hadron spectra in $e^+ e^-$ annihilation.

STRONG INTERACTIONS, GENERAL

1779 (CU-TP—123) Nontopological solitons and applications to hadrons. Lee, T.D. (Columbia Univ., New York (USA)). 12 Jun 1978. Contract EY-76-S-02-3117. 29p. (CONF-780670—1). Dep. NTIS, PC A03/MF A01.

From Symposium on solitons; Goteborg, Sweden (12 Jun 1978).

A brief review is given of some recent work done on the general nontopological soliton solutions and on their applications to hadrons as regards the soliton or bag model. The term "soliton" is used to denote any spatially confined and nondispersive solution of a classical (or quasiclassical) field theory. Stable solitons without the condition of indestructibility are considered. Restriction is made to renormalizable relativistic local field theories. 19 references. (JFP)

1780 (JINR-D—1,2-10400, pp A4.18-A4.19) Urbaryon model and large transverse momentum physics. Matsuoka, T. (Nagoya Univ. (Japan)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

On the basis of the urbaryon model the large transverse momentum two-jet production cross section is studied. It is shown that these calculations of single hadron distributions exhibit power-law scaling. Results are in a good agreement with experiments.

1781 (JINR-D—1,2-10400, pp A3-23-A3-26) Jet and fireball structure of multi-hadron processes. Shelest, V.P. (AN SSSR, Moscow. Matematicheskij Inst.). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The jet structure of multihadron production is considered from a theoretical viewpoint. It could be claimed that at q approximately = 3 to 5.5 GeV the jet contribution to the inclusive spectrum of secondaries goes mainly through the recoil effect. But already at q > 4.5 GeV this picture is replaced by the two-fireball model with the moving fireballs imitating the jet structure.

1782 (JINR-D—1,2-10400, pp A3.1-A3.4) Statistical and hydrodynamic theories of multiple production. Shuryak, E.V. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The application of statistical methods (thermo- and hydrodynamics) to hadron-hadron collisions is reviewed. According to the theory inelastic collision passes three stages: a) initial, at which system is mixed and excited; b) hydrodynamical, at which isoentropy expansion takes place; c) final, at which real secondaries are formed. Discussion proceeds backwards from final stage to initial one from more to less clear phenomena. At final stage thermodynamical equilibrium really takes place. At hydrodynamical stage motion is determined by local energy-momentum conservation. Central region grows with energy, violating scaling. The shape of spectrum in the central region is approximately gaussian. The conclusions above are based on the Fermi-Landau initial conditions with zero collective velocity. More direct investigations are connected with large transverse momentum phenomena. The explanation proposed is evaporation at stage when the temperature is higher than the final one. The weak points of theory are discussed.

1783 (JINR-D—1,2-10400, pp A4-11-A4-13) High transverse momentum processes in composite models. Tavkhelidze, A.N. (AN SSSR, Moscow. Inst. Yadernykh Issledovanij). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

High-transverse momentum processes in the study of hadron structure is investigated. The hadron A consists of the constituent particles corresponding to the fundamental fields. The inclusive cross sections of the hadron-hadron collisions are calculated when the interaction between the subsystems of constituent particles is taken into account. The representation for the single-particle distribution of the hadron is obtained in the general case when requiring the transverse momentum boundedness and neglecting the interaction inside the subsystems.

1784 Crude estimate of the number of quark flavors. Zee, A. (The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **18**: No. 7, 2600-2605(1 Oct 1978).

Extending an argument due to Landau, we attempt to estimate the number of quark flavors in SU(2) x U(1), SU(3) x U(1), and

SU(2) x SU(2) x U(1) models of weak interactions. Mass correction is crudely taken into account by assuming a semiempirical formula for quark masses m/sub n/ ~ 3/sup n/ m_0. We suggest that with a large number of fermions the unification of weak, electromagnetic and strong interactions may occur at a scale far below the Planck mass.

1785 Photon and pion emission from the nucleon-antinucleon system. Dover, C.B.; Zabek, M.C. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **41**: No. 7, 438-442(14 Aug 1978).

Quantitative estimates of the single-γ and -π emission rates for transitions between bound states of the nucleon-antinucleon system are presented. Quantum-number assignments in the context of potential and baryonium models are suggested for new mesons recently seen in monoenergetic γ emission from the p-barp atom. It is shown that π transitions are important in distinguishing between alternative models.

1786 Loosely bound states near the charm threshold. Charm molecules. Nussinov, S.; Sidhu, D.P. (Fermi National Accelerator Lab., Batavia, IL;. *Nuovo Cim., A;* **44**: No. 2, 230-240(21 Mar 1978).

The possibility of loosely bound states near the charm threshold in the charmed-particle and antiparticle system such as D anti D, Dsup(*) anti Dsup(*) is discussed. An explicit calculation shows that the S- and P-wave states exist in the D anti D system with reasonable values for the parameters of the interaction. These bound states may be very close to threshold with large sizes (r.m.s.(>=) 1 fm). Characteristics of these molecularlike states and their relationship with the quark model c anti c bound states are also discussed.

1787 Unitarity problem in the theory of the Froissaron exchange. Dubovikov, M.S.; Martirosyan, K.A.T. (Institute of Theoretical and Experimental Physics). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1052-1063(Dec 1977).

It is shown that in the theory of multipomeron exchange with α/sub P/(0) = (1+Δ) >α/sub cr/>1 (in the Froissaron theory), which leads to a Froissart growth of the cross section σ/sup tot/ ~zeta^2, the problem of s- and t-channel unitarity is connected in radical fashion with the threshold behavior of the pomeron-pole trajectory α/sub P/(t). We investigate the influence of this factor on the t-channel partial amplitude f (ω,t), where ω=j—1, and on the asymptotic s-channel profile function F (zeta,b) =1—exp[2iδ (zeta,b)], where b is the impact parameter. It is shown that, subject to some limitations on the threshold singularity of α/sub P/(t), the amplitude f (ω,t) does not contradict t-unitarity and, under the same condition at a sufficiently value of the froissaron interaction constant $g_{00} \cong \Delta^3/a^2$, the function F (zeta,b) is s-unitarity.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 1792

1788 (JINR-D—1,2-10400, pp A3.28-A3.31) **Multiparticle correlations and identical particle effects in the independent cluster emission model.** Ranft, J. (Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

In the nucleon approach to phenomenological applications, the model is compared to many different kinds of experimental data. The comparison indicates that the model is qualitatively consistent with all available data. Analysis indicates that identical particle effects due to the Bose statistics are present in data on joint rapidity-azimuthal correlations near $\Delta y = \Delta PHI = 0$. A new approach to this problem is the uncorrelated jet model with the Bose statistics. This model confirms the previous results. Furthermore, with isospin conservation taken into account, the Bose correlations are predicted in $\pi^+\pi^-$ channels, which should be most easily detectable in the decay of heavy resonances J/PSI.

1789 (JINR-D—1,2-10400, pp A1-20-A1-24) **Theory of a pomeron with $\alpha > 1$ and the fruassaron dynamics.** Ter-Martirosyan, K.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1977. (In R ssian).

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Pomeron theory with $\alpha > 1$ which satisfies s and t unitarity and describes data on experiments with small transverse momenta is considered. The contribution of the p-trajectory is reduced in the eikonal series by successive rescatterings. The amplitude which leads to experimentally observed growth in the total cross section value is called by the author a fruassaron. This amplitude is written without account of enhanced graphs. It is shown that their account does not lead to s unitarity violation, and the fruassaron describes well enough all the experimental data already known.

1790 NN-bar quasinuclear states and the Bethe-Salpeter equation. Tjon, J.A. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **18**: No. 7, 2565-2568(1 Oct 1978).

Using the Bethe-Salpeter equation with one-boson exchange the energies of nN-bar bound states and resonances are determined up to the one-pion production threshold. Comparisons are made with calculations using the Blankenbecler-Sugar approximation. It is found that the NN-bar forces are much less attractive in the Bethe-Salpeter approach. In contrast to the one-mass-shell models, the NN-bar spectrum for the high-lying states contains more I = 1 than I = 0 states.

1791 Nucleon and antinucleon annihilation cross section at nonrelativistic energies. Ksenzov, V.G.; Kudroyavtsev, A.E. (Institute of Theoretical and Experimental Physics). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 3, 184-187(5 Feb 1978).

It is shown for the low-energy NN-bar interaction, within the framework of the coupled-channel scheme, that in the case of a small annihilation radius r/sub a/ ~m/sub N//sup ts-1/ ~0.2 F and strong attraction it is possible to obtain a consistent description of the small widths of the quasinuclear mesons ($\Gamma \sim 10$—30 MeV) and the large annihilation cross sections. The slow NN-bar annihilation cross section deviates in this case from the 1/v law. The character of the deviation depends on the potential NN-bar interaction.

STRONG INTERACTIONS, BARYON NO.=1

1792 (COO—1545-238) **Results from a partial wave analysis of the eta$\pi^+\pi^-$ system produced in π^- p → eta$\pi^+\pi^-$ n at 8.45 GeV/c.** Edwards, K.W.; Legacey, D.; Brockman, P. (Carleton Univ., Ottawa, Ontario (Canada). Dept. of Physics; McGill Univ., Montreal, Quebec (Canada). Dept. of Physics; Northeastern Univ., Boston, MA (USA). Dept. of Physics; Ohio State Univ., Columbus (USA). Dept. of Physics; Toronto Univ., Ontario (Canada). Dept. of Physics). 1978. Contract EY-76-C-02-1545. 12p. (CONF-780826—2). Dep. NTIS, PC A02/MF A01.

From 19. conference on high energy physics; Tokyo, Japan (23 Aug 1978).

The first results from an isobar-model phase shift analysis of the eta$\pi^+\pi^-$ system are presented. Particular emphasis is given to an unambiguous determination of the spin-parity of the D(1285) meson.

1793 (JINR-D—1,2-10400, pp C87-C88) **Amplitude and phase shift analysis of binary reactions in the resonance region.** Oades, G.C. (Aarhus Univ. (Denmark). Inst. of Physics). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The perspective recent work in the field of amplitude and phase shift analysis is elucidated. A typical first-generation phase shift analysis is considered where a finite number of unitary partial wave amplitudes are fitted to experimental scattering data. Removing this unphysical restriction gives rise to a continuum ambiguity. For studying this ambiguity a method was constructed of producing an identical fit to the data with low partial waves plus a "tail" of unitarity high partial waves with the correct exponential fall-off. There are two lines to remove ambiguitis. Both methods use dispersion relations. The AEE (accelerated convergence expansion) method is used to avoid a sudden cut-off in the partial wave expansion, and each partial wave is subjected to a smoothness constraint via partial wave dispersion relations. The other method starts with a fixed+t amplitude analysis. Using a suitable mapping the invariant amplitudes are expanded in a way which ensures the correct fixed-t analyticity and which gives a suitable high-energy behavior. The coefficients of the expansions are then determined by fitting to all available data.

1794 Quark-cluster model of dibaryon resonances. Lichtenberg, D.B.; Predazzi, E.; Weingarten, D.H.; Wills, J.G. (Physics Department, Indiana University, Bloomington, Indiana 47401). *Phys. Rev., D;* **18**: No. 7, 2569-2573(1 Oct 1978).

We suggest that a recently discovered dibaryon resonance is composed of quark clusters such as a quadriquark and a diquark or a pentaquarkand a quark.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

REFER ALSO TO CITATION(S) 1892

1795 (JINR-D—1,2-10400, pp A4-9-A4-11) **Recent developments in the theory of large transverse momentum processes.** Stanley.

J. Brodsky (Stanford Linear Accelerator Center, Calif. (USA)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

One of the most important questions in hadron dynamics is the understanding of the underlying mechanisms for the production of large-transverse-momentum particles. The emerging features of the associated particles accompanying a high-p/sub T/ trigger (jet structure, coplanarity, angular correlations, scaling laws) lend support to an underlying two-body hard scattering mechanism. Although it was natural to hope that the basic large psub(UPSILON) mechanism could be related to elementary quark-quark scattering, the new proton target data at FNAL appeared to rule this out. The evidence is reviewed for this, and a comparison is given with the predictions of the constituent interchange model (CIM), which postulates that the important subprocesses involve quark-hadron scattering.

1796 (JINR-D—1,2-10400, pp A1-1-A1-3) **Fine structure of the diffraction peak.** Tsarev, V.A. (AN SSSR, Moscow. Fizicheskij Inst.). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Recent measurements revealed rich structure of the differential cross section and polarization of elastic hadron-hadron scattering. The possibility of a small-scale structure was also discussed theoretically. New data seem to give quite clearcut evidence for such structure. The model is discussed connecting the small-scale oscillations in the differential cross sections for the proton-proton interaction with the existence of peripheral inelastic diffraction.

1797 **Production of real photons at large transverse momentum in pp collisions.** Rueckl, R.; Brodsky, S.J.; Gunion, J.F. (Department of Physics, University of California, Los Angeles, California 90024). *Phys. Rev., D;* **18**: No. 7, 2469-2483(1 Oct 1978).

The production of photons at large transverse momentum can be used as a direct probe of quark and gluon subprocesses at short distances. We calculate the cross section for high-p/sub T/ photons produced in pp collisions from lowest-order quantum-chromodynamics (QCD) and higher-order constituent-interchange-model (CIM) processes. We find that CIM terms dominate both γ and π spectra until very high p/sub T/-although there are regions of s and p/sub T/ where the CIM contributions dominate the γ spectrum but the γ spectrum already shows the scaling behavior of lowest-order QCD, and also vice versa. We emphasize that in some processes (e.g., gluon + quark → photon + quark), the photon is produced without accompanying toward-side hadrons.

1798 **Study of scaling in hadronic production of dimuons.** Yoh, J.K.; Herb, S.W.; Hom, D.C.; Lederman, L.M.; Sens, J.C.; Snyder, H.D.; Ueno, K.; Brown, B.C.; Brown, C.N.; Innes, W.R.; Kephart, R.D.; Yamanouchi, T.; Fisk, R.J.; Ito, A.S.; Joestlein, H.; Kaplan, D.M. (Columbia University, New York, New York 10027). *Phys. Rev. Lett.;* **41**: No. 10, 684-687(4 Sep 1978).

We present proton-nucleus dimuon-production cross sections for masses between 4 and 15 GeV, center-of-mass rapidities between -0.23 and 0.6 and incident energies of 200, 300, and 400 GeV. The data confirm scaling to the 20% level. The dependence of continuum < p/sub T/ > on beam energy is also presented.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

1799 (SLAC-PUB—2134) **Weak interactions.** Bjorken, J.D. (Stanford Linear Accelerator Center, CA (USA)). Jun 1978. Contract EY-76-S-03-0326. 9p. (CONF-780353—3). Dep. NTIS, PC A02/MF A01.

From 13. high energy hadronic interactions sessions; Les Arcs, France (12 Mar 1978).

The weak interaction is studied from a phenomenological viewpoint. The aim is to describe the present situation concisely, using a minimal number of theoretical hypotheses. First, charged-current phenomenology is discussed, then neutral-current phenomenology. This can all be described in terms of a global SU(2) symmetry plus an electromagnetic correction. The intermediate-boson hypothesis is then introduced, and lower bounds are inferred on the range of the weak force. 18 references. (JFP)

1800 **Charged Higgs boson.** Tomozawa, Y. (Randall Laboratory of Physics, University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev., D;* **18**: No. 7, 2556-2564(1 Oct 1978).

Assuming that there are more than one Higgs scalar doublet, we discuss the characteristics of the observable charged Higgs boson H^{+-} in the context of a vectorlike model of the SU(2) x U(1) gauge field theory. In particular, the production and the subsequent decay of H^{+-}, the contribution to the muon magnetic-moment anomaly, and the contribution to the trimuon events in the neutrino reaction are surveyed.

1801 **Pattern of symmetry breaking with two Higgs doublets.** Deshpande, N.G.; Ma, E. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). *Phys. Rev., D;* **18**: No. 7, 2574-2576(1 Oct 1978).

We analyze fully the pattern of symmetry breaking of an SU(2) x U(1) gauge model with two Higgs doublets. We find the phenomenon of spin-zero leptons to be a very general one, and obtain a solution previously obtained by one of us as a limiting case.

FIELD THEORY

REFER ALSO TO CITATION(S) 1779

1802 (JINR-D—1,2-10400, pp A4-13-A4-15) **Large p/sub T/ inclusive distributions in composite models.** Slepchenko, L.A. (Tbilisskij Gosudarstvennyj Univ. (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

In the framework of three-dimensional formulation of the quantum field theory of composite systems the general representation for a production distribution was obtained. Some applications of this approach are briefly enumerated. Only two aspects of the high-transverse-momentum phenomena are discussed: leading particle mechanism and interaction of jets. An interaction of two jets can be considered as a coherent process where the multiple rescattering may play a significant role.

1803 (JINR-D—1,2-10400, pp C84-C86) **Hadron physics in quantum chiral theory.** Volkov, M.K. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The one-loop approximation in the chiral field theory is considered to describe low-energy hadron physics. In this approximation it is possible to get information on such fundamental properties of hadrons as scattering lengths of higher partial waves, form factors and polarizabilities of mesons, decay structure constants, etc. Strong, electromagnetic and weak interactions are described. Information on the chiral SU(2)xSU(2) symmetry breaking from the experimental data on $\pi N \to \pi\pi N$ is analyzed. It is impossible to define the chiral symmetry breaking term without consideration of the one-loop approximation of contributions of resonances.

1804 **Asymptotic graph counting techniques in psi/sup 2N/ field theory.** Bender, C.M.; Caswell, W.E. (Department of Physics, Washington University, St. Louis, Missouri 63130). *J. Math. Phys. (N.Y.);* **19**: No. 12, 2579-2586(Dec 1978).

We discuss two different techniques for obtaining asymptotic estimates of the number of n-vertex graphs in a psi/sup 2N/ field theory as $n \to \infty$. The first technique relies on difference equations and the second makes use of Lipatov's methods. We show how various topological constraints, such as connectedness and Wick ordering, affect the total number of graphs. We show, for example, that Wick ordering reduces the total number of connected graphs by a factor of e/sup N/-1/2 as $n \to \infty$.

1805 **Color embeddings, charge assignments, and proton stability in unified gauge theories.** Gell-Mann, M.; Ramond, P.; Slansky, R. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Rev. Mod. Phys.;* **50**: No. 4, 721-744(Oct 1978).

Three problems in hypothetical unified theories of electromagnetic, weak, and strong interactions are discussed here. First, the problem of embedding color in any simple gauge group is solved, and a complete classification of theories where the fermion color is restricted to 1/sup c/, 3/sup c/, and 3/sup c/ of SU/sup c/$_3$ is given. Generalizations are also indicated. Second, an unbroken U_1 generated by electric charge is embedded into each of the above theories and the charge assignments analyzed. Third, the general problem of stabilizing the proton by a suitable atomic mass number A is studied for the same set of theories. It is always possible to define A if the

gauge group is not too small. In many of these theories there must be fermions with weird values of A: leptons with Anot =0 and quarks with Anot =1/3. Examples are discussed. Some future directions of research are indicated.

1806 Number and weights of Feynman diagrams. Cvitanovic, P.; Lautrup, B.; Pearson, R.B. (The Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **18**: No. 6, 1939-1949(15 Sep 1978).

The functional techniques of field theory are adapted to the problem of evaluating sums of combinatoric and group-theoretic weights of Feynman diagrams in phi/sup N/, quantum electrodynamics and non-Abelian theories. Considered are various classes of diagrams such as connected, one-particle-irreducible, and skeleton diagrams. For finite orders exact sume are given by compact recursion formulas. For higher orders estimates are obtained from the exact results or by steepest-descent methods.

1807 Structure and renormalizability of massive Yang-Mills field theories. Bardeen, W.A.; Shizuya, K. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **18**: No. 6, 1969-1982(15 Sep 1978).

We observe that the theory of the Yang-Mills field with bare mass is included in the framework of spontaneously broken gauge theories, except that the Higgs field is realized nonlinearly. With the nonlinear symmetry associated with the Higgs field taken into account, the SU(N) massive Yang-Mills theory and the associated SU(N)/sub L/ x SU(N)/sub R/ nonlinear σ model are shown to be renormalizable and asymptotically free theories in two dimensions.

1808 General self-dual Yang-Mills solutions. Christ, N.H.; Weinberg, E.J.; Stanton, N.K. (Department of Physics, Columbia University, New York, New York). *Phys. Rev., D;* **18**: No. 6, 2013-2025(15 Sep 1978).

The recent work of Atiyah, Hitchin, Drinfeld, and Manin is used to discuss self-dual Yang-Mills solutions for the compact gauge groups O(n), SU(n), and SP(n). It is shown that the resulting solutions contain the correct number of parameters for all values of the topological charge. Although explicit construction of a general self-dual field requires the solution of a finite-dimensional, nonlinear matrix equation, we show that for widely separated instantons this equation can be solved perturbatively, providing a systematic expansion about the dilute-gas limit and a physical interpretation of the independent parameters in this limit. Further, closed-form expressions can be obtained for the general SU(2) solutions with topological charge 2 or 3. Finally, explicit isospin-1/2 and isospin-1 propagators are derived for a massless scalar field in the presence of the general self-dual SU(2) solution.

1809 Instanton interactions at the one-loop level. Bernard, C. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* **18**: No. 6, 2026-2041(15 Sep 1978).

We discuss the interactions between widely separated instantons (but not instantons and anti-instantons) due to the one-loop fluctuations in a non-Abelian gauge theory. A slightly generalized version of the recent calculation of Brown and Creamer for the one-loop determinant about an exact self-dual solution is used as a starting point. An apparently dangerous $1/r^2$ interaction is found to disappear with the proper parametrization of the exact solution. As a by-product of our procedure, we develop a more precise understanding of the relation between exact solutions of topological charge k and the superposition of k instantons. In particular, the meaning of the parameters of the Jackiw-Nohl-Rebbi k = 2 solution is understood in these terms.

1810 Constructive method for the lattice gauge theory. Baaquie, B.E. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **18**: No. 6, 2056-2061(15 Sep 1978).

A method is given for defining gauge-invariant actions for the lattice theory. The basic idea is to first define the theory without respecting guage invariance, and then study its gauge-invariant projection. The constraints that the lattice theory exhibit free-field behavior for weak coupling and disorder for strong coupling limits us to a special set of possible actions. We study the simplest of these nontrivial theories, which involves a nonlinear nearest-neighbor scalar coupling. This theory has a phase transition which separates the weak- and strong-coupling sectors. For dimension near 4, the phase transition from the strong-coupling phase to the weak-coupling phase is shown to be a continuous (second-order) phase transition.

1811 Note on dual transformations in phi^4 field theories. Banks, T. (Institute for Advanced Study, Princeton, New Jersey 08540). *Phys. Rev., D;* **18**: No. 6, 2193-2195(15 Sep 1978).

The dual transformations introduced by Chang and Magruder in two- and three-dimensional phi^4 field theories are rederived and extended to four dimensions by using homogeneous renormalization-group equations.

1812 Linearizing the Volkov-Akulov model. Rocek, M. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev. Lett.;* **41**: No. 7, 451-453(14 Aug 1978).

The nonlinear realization of supersymmetry of Volkov and Akulov is related to a constrained linear realization in two and four dimensions.

1813 Feynman rules for lattice gauge theory. Creutz, M. (Brookhaven National Laboratory, Upton, NY 11973). *Rev. Mod. Phys.;* **50**: No. 3, 561-571(Jul 1978).

We use functional techniques to give a simple derivation of Wilson's Feynman rules for strongly coupled gauge theory formulated on a lattice. Coupling sources to the various degrees of freedom, we obtain a compact formal expression for the Green's functions of the theory. The theory is rewritten in terms of creation and annihilation operators for quarks and "string bits" in a new space called "string space." This formulation emphasizes the close analogy with a lattice version of the string model. We also give a systematic diagrammatic procedure to evaluate all group integrations arising in the strong coupling expansion.

1814 Crystallization of Yang-Mills fields in superdense matter. Linde, A.D. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 8, 441-443(20 Apr 1978).

An exact classical solution, in the form of a standing wave with zero energy, is obtained for the Yang-Mills field in a medium.

1815 Particle-like solutions of the scalar Higgs equation. Belova, T.I.; Voronov, N.A.; Kobzarev, I.Y.; Konyukhova, N.B. (Institute of Theoretical and Experimental Physics). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 846-852(Nov 1977).

The properties of particle-like solutions of the scalar Higgs equation are considered. These solutions should correspond in the Vinciarelli-Drell model to gluon-type mesons that contain no quark-antiquark pair.

1816 Concerning a bound neutron in matter. Seregin, A.A. *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 859-861(Nov 1977).

An experiment is proposed for the detection of quasistationary neutron states in matter. It is based on the resonance dependence of the transmission coefficient of a neutron passing through a double-hump barrier. The feasibility of constructing a neutron spectrometer for neutrons with energies $<$ or $\approx 10^{-7}$ eV is discussed.

SCATTERING THEORY

1817 (SLAC-PUB—2114) Zero range three-particle equations. Noyes, H.P.; Zeiger, E.M. (Stanford Linear Accelerator Center, CA (USA)). Apr 1978. Contract EY-76-S-03-0326. 8p. Dep. NTIS, PC A02/MF A01.

In order to separate the entire effect of two-particle on-shell scatterings in three-particle systems from the effects of hidden mesonic degrees of freedom (off-shell effects and three-body forces), the zero range limit of the Karlsson-Zeiger equations. Although the Faddeev equations are ambiguous in this limit, the KZ equations remain well defined. Using only two-particle phase shifts, binding energies, and reduced widths, these zero-range equations uniquely predict the three-particle observables which would occur in the absence of hidden mesonic degrees of freedom. The three-particle amplitudes possess all requisite physical symmetry properties, and can be proved to be unitary if the spectator basis is orthonormal and complete. Possible extensions of the scheme for the analysis of three-particle final states, to zero range four-particle equations, and to relativistic systems are conjectured.

1818 Validity and significance of time-dependent Hartree approximation for a one-dimensional system of bosons with attractive δ-function interactions. Klein, A.; Krejs, F. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19174). *Phys. Rev., A;* **18**: No. 4, 1343-1352(Oct 1978).

The Hartree (mean-field) approximation to the description of the scattering of two heavy bound states is studied in a model consisting of bosons with attractive δ-function interactions. The approximation is derived from matrix elements of the Heisenberg equations of motion of the system and requires careful enumeration of all necessary approximations. The arguments made are verified by comparison of exact and approximate scattering amplitudes. The derivation also yields the physical significance of the amplitude which satisfies the Hartree approximation; it is a Fourier sum over amplitudes for different channels, which can in prinicple be recovered individually. The approach is not restricted to the model studied.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

1819 (JINR-D—1,2-10400, pp A6.3-A6.5) **Nuclear scaling.** Leksin, G.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1977. (In Russian).

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Deep inelastic nuclear reactions are considered. A great deal of attention is paid to he a+A→b+ type reaction, where a is any incident particle, A is any target nucleus b is a baryon (proton, Λ^0) backscattered in the laboratory coordinate system at energy > 30 MeV. The invariant function has an exponential character. The index of the invariant function does not depend on the energy or sort of incident particle or the type of a target nucleus. Pre-exponential multiplier does not depend on the energy or sort of an incident particle either. The dependence earlier observed for cumulative pions exists also in the case of protons. Study on correlations of secondary particles in deep inelastic nuclear reactions suggests the independence within the experimental errors of characteristics of secondary particles from the behavior of leading particles. All the conclusions are valid both for deep inelastic reactions and for cumulative meson production. Because of the analogy with a scaling phenomenon in elementary particle interactions the phenomenon is called nuclear scaling.

EXPERIMENTAL TECHNIQUES

REFER ALSO TO CITATION(S) 1268

1820 **Polarization phenomena in nuclear reactions.** Barit, I.Y.; Vysotskii, G.L.; Krivopustov, M.I.; Slabospitskii, R.P. (Nuclear Research Institute, USSR Academy of Sciences, Moscow). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 6, 529-549(Nov 1977).

The main recent developments in experimental and theoretical investigations into polarization phenomena in nuclear reactions at low and medium energies are reviewed. Their role in establishing the spin dependence of the nuclear interactions, the spectroscopic information they provide, and the models used to describe polarization phenomena are discussed.

1821 **Workshop on new directions in Moessbauer spectroscopy (Argonne 1977).** Perlow, G.J. (ed.). Contract W-31-109-ENG-38. New York; American Institute of Physics, Inc. (1977). 160p. (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

The individual papers were abstracted separately for the data base.

1822 **Improving the resolution of small energy shifts using ^{67}Zn and ^{181}Ta.** Pound, R.V. (Harvard Univ., Cambridge, MA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 41-45(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Moessbauer resonance, as the electromagnetic phenomenon with the smallest known ratio of linewidth to energy, provides a medium for seeking and measuring minute fractional energy shifts that result from external influences. The effect of a change of gravitational potential is probably the most widely known such application. The use of ^{67}Zm and ^{181}Ta as the primary media for high resolution applications is discussed.

1823 **Coherent nuclear scattering of synchrotron radiation.** Trammell, G.T. (Rice Univ., Houston, TX); Hannon, J.P.; Ruby, S.L.; Flinn, P.; Moessbauer, R.L.; Parak, F. *AIP (Am. Inst. Phys.) Conf. Proc.:* No. 38, 46-49(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Synchrotron radiation from modern electron storage rings can furnish brighter sources of Moessbauer radiation than radioactive sources if appropriate filtering can be devised. The object is to pass the power in the synchrotron radiation which lies in the spectral range within a few natural widths of the nuclear resonance, with as little diminution as possible, and to reduce that passed outside this range to a fraction of the filtered radiation. The methods which can be used to filter are considered, and estimates of the efficiency of the various filter schemes are made.

1824 **Coherence and interference in the Moessbauer effect.** Lipkin, H.J. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 63-71(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Some early history of the Moessbauer effect is reviewed, and the complementarity coherence and interference is discussed. (JFP)

1825 **Moessbauer experiments in analogy to optical activity.** Gonser, U. (Universitaet des Saarlandes, Saarbruecken, Ger.); Engelmann, H.; Brunner, H.; Muschiol, M.; Nowak, W. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 87-90(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

It is pointed out that the linearly polarized γ-radiation from the source (polarizer) can be represented as a superposition of right and left circularly polarized γ-radiation, and the optical effects of the γ-radiation transversing the transmitter can be understood by considering the corresponding indices of refraction.

1826 **Preliminary report of an experiment to excite nuclear resonance by synchrotron radiation.** Cohen, R.L.; Miller, G.L.; West, K.W. (Bell Labs., Murray Hill, NJ). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 91-92(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

A run to excite nuclear levels via synchrotron radiation was carried out. These experiments used a given configuration to excite the 14-keV 100 nsec state of ^{57}Fe, and observe the subsequent decay of this state via the emission of conversion electrons. The most significant result is the demonstration that the "between pulse" background radiation is at least 10^5 to 10^6 less than the pulse intensity. This value was not previously established. (JFP)

1827 **Fast data acquisition in Moessbauer spectroscopy.** Kalvius, G.M. (Technische Universitaet Muenchen, Garching, Ger.); Potzel, W.; Koch, W.; Forster, A.; Asch, L.; Wagner, F.E.; Halder, N. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 93-101(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Three different gamma-ray detection systems for Moessbauer measurements at count rates above 10^5 s^{-1} are described. The first uses the fast output of an uncooled NaI(Tl) scintillation counter and will still provide energy discrimination at total pulse rates up to 10^6 s^{-1}. Count rates up to some 10^7 s^{-1} can be handled by a tin-loaded plastic scintillation detector, but only with very limited energy resolution. For even higher photon intensities, the method of current integration is available. The various techniques are illustrated and compared on the basis of measurements with the Moessbauer resonances in ^{170}Yb (84 keV), ^{199}Hg (158 keV) and ^{237}Np (60 keV).

1828 **Results obtained with the integrating counting technique applied to ^{197}Au Moessbauer spectroscopy.** Viegers, M.P.A.; Trooster, J.M. (Univ. of Nijmegen, Netherlands). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 102-106(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

This paper describes in some detail the application of the integrating counting technique to ^{197}Au spectroscopy. In this method no pulse height discrimination is applied but the total detector current is measured.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 1829

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1817, 1894, 2104

1829 (LA-UR—78-1577) **Light nuclei: an experimental proving ground for the microscopic cluster model.** Brown, R.E. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 23p. (CONF-780644—3). Dep. NTIS, PC A02/MF A01.

From 3. conference on clustering aspects of nuclear structure and nuclear reactions; Winnipeg, Canada (19 Jun 1978).

A selected review is given of comparisons of experimental data for low-mass nuclear systems with results of calculations using microscopic cluster models. Stress is on the mass-4, -7, and -8 systems. Topics include influence of components of the nucleon-nucleon force, some consequences of the Pauli principle, effects of the Coulomb-exchange interaction, specific distortion, absorption in

elastic scattering, and future needs and directions. Some as yet unpublished results are presented.

1830 Threshold pion photoproduction and radiative pion capture. III. ^{3}He bold-arrow-left-right ^{3}H. Gibbs, W.R.; Gibson, B.F.; Stephenson, G.J. Jr. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **18**: No. 4, 1761-1763(Oct 1978).

We have calculated the rate for radiative pion capture from a 1s atomic orbital for the ^{3}He(π^-,γ)^{3}H analog transition. We obtain reasonable agreement with the experimental Panofsky ratio when this radiative capture rate is combined with our estimate of the corresponding ^{3}H(π^-,π^0)^{3}H charge exchange rate. Threshold pion photoproduction cross section estimates are also given.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

1831 (CONF-780926—3) **^{1}H(n,γ) reaction gamma-ray energy: revised neutron binding energies for ^{3}T, ^{13}C, ^{14}C, and ^{15}N.** Greenwood, R.C.; Chrien, R.E. (Idaho National Engineering Lab., Idaho Falls (USA); Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-07-1570. 6p. Dep. NTIS, PC A02/MF A01.

From 3. symposium on neutron capture of gamma-ray spectroscopy; Upton, NY, USA (18 Sep 1978).

The ^{1}H(n,γ) reaction γ-ray energy was measured and from it a value was obtained for the deuterium binding energy. Combining this B/sub n/(^{2}D) with mass differences, values of B/sub n/ were obtained for ^{3}T, ^{13}C, ^{14}C and ^{15}N.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 1829

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1699, 1721, 1829, 1831

1832 (JINR-D—1,2-10400, pp A6.6-A6.9) **Interactions of few-nucleon systems at relativistic energies.** Zielinski, I.P. (Institute of Nuclear Research, Warsaw (Poland)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Some results obtained using the deuteron (10 GeV) and alpha (20 GeV) beams at the Dubna synchrophasotron are presented. The results are divided into three sections according to the experimental techniques used. The first section concerns interactions of 3.3 GeV/c deuterons and protons using a hydrogen bubble chamber. In the second section some preliminary results obtained using the recoil measurement technique are presented, and in the third - preliminary results on a search for α-particle scattering at 17.9 GeV/c on p, He, C, Al, Cu, Pb, using a magnetic spectrometer with a multiwire proportional chamber and dE/dx detectors. Preliminary results are rather consistent with Glauber theory predictions. There are however some deviations of an oscillatory type of experimental differential cross sections from the Glauber ones for α-C, α-Al, α-Cu scatterings.

1833 Nucleus-nucleus total cross sections for light nuclei at 1.55 and 2.89 GeV/c per nucleon. Jaros, J.; Wagner, A.; Anderson, L.; Chamberlain, O.; Fuzesy, R.Z.; Gallup, J.; Gorn, W.; Schroeder, L.; Shannon, S.; Shapiro, G.; Steiner, H. (Lawrence Berkeley Laboratory and Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., C;* **18**: No. 5, 2273-2292(Nov 1978).

We have measured total cross sections for protons, dueterons, α particles, and ^{12}C on hydrogen, deuterium, helium, and carbon targets at 1.55 and 2.89 GeV/c nucleon using the "good geometry" transmission method. In addition, we measured the inelastic cross sections and elastic slope parameters for reactions initiated by deuterons, α particles, and ^{12}C. Our results are in good agreement with Glauber theory predictions, but the factorization relation σ/sub T/(AA) = [σ/sub T/(AB)]^2/ σ/sub T/(BB) is not a good guide. We find σ/sub T/ ≅ 144(A/sub T//sup 1/3/ - A/sub p//sup 1/3/ - 1.48)^2 mb and σ/sub I/N ≅ 78(A/sub T//sup 1/3/ + A/sub p//sup 1/3/ - 1.25)^2 mb, where A/sub T/(A/sub p/) is the atomic mass number of the target (projectile).

1834 Some recent intermediate-and high-energy proton—nucleus research. Igo, G.J. (Department of Physics, University of California, Los Angeles, California 90024). *Rev. Mod. Phys.;* **50**: No. 3, 523-560(Jul 1978).

A review of several new or very active areas of research in the field of intermediate-and high-energy proton—nucleus research is presented. Theoretical advances used in treating the data are described. The areas covered include: p-^{4}He elastic scattering and polarization; elastic and inelastic scattering, A> or =4; the neutron pickup reaction; and particle production and elastic scattering near 180°.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1894, 2104

1835 Quadrupole scattering of pions by ^{9}Be. Geesaman, D.F.; Olmer, C.; Zeidman, B.; Boudrie, R.; Siemssen, R.H.; Amann, J.F.; Morris, C.L.; Thiessen, H.A.; Burleson, G.R.; Devereux, M.J.; Segel, R.E.; Swenson, L.W. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **18**: No. 5, 2223-2226(Nov 1978).

The results for π^{+-} + ^{9}Be elastic scattering at E/sub lab/ = 162 MeV are shown to provide evidence for quadrupole contributions to the elastic scattering of pions. The strong-coupling rotational model is used to relate the measured inelastic scattering cross sections to the elastic scattering cross sections.

1836 Analysis of 0.8-GeV polarized-proton elastic scattering from ^{208}Pb, ^{90}Zr, ^{58}Ni, and ^{12}C. Ray, L.; Hoffmann, G.W.; Blanpied, G.S.; Coker, W.R.; Liljestrand, R.P. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **18**: No. 4, 1756-1760(Oct 1978).

Differential cross section and analyzing power data for elastic scattering of 0.8-GeV polarized protons from ^{12}C, ^{58}Ni, ^{90}Zr, and ^{208}Pb have been analyzed in terms of the Kerman-McManus-Thaler formalism using spin-dependent nucleon-nucleon scattering amplitudes. The derived results for nuclear matter densities are in good agreement with theoretical predictions. Uncertainties in the deduced neutron distributions are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 1831

ENERGY LEVELS AND TRANSITIONS

1837 Effects of channel and potential radiative transitions in the ^{17}O(γ,n$_0$)^{16}O reaction. Holt, R.J.; Jackson, H.E.; Laszewski, R.M.; Monahan, J.E.; Specht, J.R. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **18**: No. 5, 1962-1972(Nov 1978).

The angular distribution for the ^{17}O(γ,n$_0$)^{16}O reaction was observed throughout the excitation energy region 4.3—7 MeV and at angles of 90° and 135°. The ground-state radiation widths for resonances in this energy region were extracted from the data. The value of the radiation width for the d/sub 5/2/ → d/sub 3/2/ spin-flip transition at 5.08 MeV was found to be approximately 1/3 of the value expected for a pure single-particle transition. The implications that this result has for the nuclear structure of ^{17}O is discussed. The effects of potential radiative capture were observed directly in a photoneutron reaction for the first time. At the location of the 5.38-MeV, 3/2$^-$ resonance in ^{17}O, an anomalous symmetric dip was observed in the cross section at both reaction angles. The data were interpreted in terms of a general R-matrix reaction theory which includes the effects of internal, channel, and potential radiative capture in a self-consistent manner. The neutron channel was defined by incorporating an R-matrix analysis of the ^{16}O(n,n)^{16}O reaction into the present interpretation. The anomalous minimum at 5.38 MeV was found to be due to a unique feature of channel capture. The R-matrix prediction for the total cross section was extrapolated into the keV region and the significance that this cross section has for stellar nucleosynthesis is disucssed.

1838 Gamma decays of the first T = 3/2 states in ^{9}Be and ^{9}B. Dickey, P.A.; Dyer, P.L.; Snover, K.A.; Adelberger, E.G. (Nuclear Physics Laboraotry, University of Washington, Seattle, Washington 98195). *Phys. Rev., C;* **18**: No. 5, 1973-1984(Nov 1978).

We have measured the γ-ray branching ratios of the lowest T = 3/2 states in the isospin mirror nuclei ^{9}Be and ^{9}B. The ratio of reduced M1 transition strengths B/sub gamma2/(M1)/ B/sub gamma0/(M1) = 1.97 +- 0.12 in ^{9}Be and 1.76 +- 0.21 in ^{9}Be and hence shows no charge asymmetry, in agreement with the usual selection rules for ΔT = 1 electromagnetic transitions. A value of

(1.92 +- 2.1) % is derived for the relative size of any isotensor amplitudes for the M1 transitions. For the total widths of the T = 3/2 levels we find Γ (^{9}Be) = 381 +- 33 eV, Γ (^{9}B) = 395 +- 42 eV, and Γ (^{9}B)/Γ (^{9}Be) = 1.04 +- 0.10, assuming B/sub gamma0/(M1,^{9}B) = B/sub gamma0/(M1,^{9}Be) and Γ/sub gamma0/ = 6.9 +- 0.5 eV in ^{9}Be. The γ-ray transition strengths are compared with theoretical calculations and with the analogous β decay of ^{9}Li.

1839 Perturbed-angular-correlation measurement of a Fermi to Gamow-Teller mixing ratio in the β decay of ^{19}O. Perlman, D.M.; Grodzins, L.; Thorn, C.E. (Laboratory for Nuclear Science and Department of Physics, M.I.T., Cambridge, Massachusetts 02139). *Phys. Rev., C;* **18**: No. 5, 2333-2341(Nov 1978).

Time-differential β-γ angular correlations perturbed by the nuclear quadrupole interaction in a zinc single crystal were used to extract a value of y = + 0.030 +- 0.015 for the ratio C/sub V/M/sub F//C/sub A/M/sub GT/ of Fermi to Gamow-Teller matrix elements in the allowed β^- decay from the 5/2$^+$ ^{19}O ground state to the 5/2$^+$, 197 keV state in ^{19}F. This leads to a figure of M/sub F/ = (4.7 +- 2.4) x 10^{-3} for the isospin-forbidden Fermi matrix element. Other parameters which can be derived from this number are α = (2.7 +- 1.4) x 10^{-3} for the admixture of the analog of the ^{19}O ground state in the ^{19}F excited state and vertical-barH/sub CD/vertical-bar = 20 +- 10 keV for the effective charge-dependent matrix element. A value of ω_0 = + 8.5 +- 0.5 μsec^{-1} was determined for the nuclear quadrupole interaction of the ^{19}F excited state in a zinc single crystal. The calibration provided by the pure Gamow-Teller decay to the 3/2$^+$ 1.554 keV state in ^{19}F was used to remove effects of the implantation process, and data analysis was performed with a model which incorporated the effects of β's backscattered by the thick crystal.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1721, 1832, 1834

1840 (RLO—2232-T1-6) Total pion cross section measurements. Annual progress report, 1 January 1977—31 December 1978. Jakobson, M.J.; Jeppesen, R.H. (Montana Univ., Missoula (USA)). 20 Jan 1978. Contract EY-76-S-06-2232-001. 6p. Dep. NTIS, PC A02/MF A01.

The pion-nucleus total cross section runs were completed. The principal effort for the past year has been devoted to data analysis. The experiment was primarily designed to provide an accurate measurement of total cross section differences for pairs of isotopes. Data were published on neutron radii of calcium isotopes and on pion cross section measurements for aligned holmium. The π+- data to be published include targets and energies for ^{4}He, 23 → 90 MeV; ^{12}C, ^{13}C, 23 → 240 MeV; ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, 43 → 215 MeV; ^{16}O, ^{18}O, ^{40}Ca, ^{44}Ca, ^{48}Ca, 43 → 240 MeV; ^{45}Sc, ^{51}V, Al, Cu, Sn, Ho, Pb, 60 → 215 MeV.

1841 Gamma decays of 2.97-MeV doublet in ^{20}F. Legg, J.C.; Crozier, D.J.; Seaman, G.G.; Fortune, H.T. (Physics Department, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev., C;* **18**: No. 5, 2202-2203(Nov 1978).

The new member of the 2.97-MeV doublet in ^{20}F has a dominant γ decay to a (3$^-$) state at 1971 keV, further evidence that the new state has J/sup π/ = (4$^-$). The excitation energy is 2968.0 +- 1.5 keV.

1842 Elastic pion scattering from /sup 6,7/Li and /sup 12,13/C. Dytman, S.A.; Amann, J.F.; Barnes, P.D.; Craig, J.N.; Doss, K.G.R.; Eisenstein, R.A.; Sherman, J.D.; Wharton, W.R.; Burleson, G.R.; Verbeck, S.L.; Peterson, R.J.; Thiessen, H.A. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., C;* **18**: No. 5, 2316-2323(Nov 1978).

Elastic scattering of 50 MeV π^+ projectiles from targets of /sup 6,7/Li and /sup 12,13/C has been studied. Effects due to isotopic differences between targets are clearly visible in the data. The results are compared to three model descriptions for the cross section ratios for isotope pairs; in the case of ^{12}C-^{13}C a simple core-plus-valence-neutron model works well for ^{13}C if the core (^{12}C) potential describes observed ^{12}C elastic scattering. Such a model does not work for the ^{6}Li-^{7}Li ratio due to improper treatment of the scattering process and the quadrupole moments of the Li ground states.

1843 Production of jets and single particles at high p(transverse) in 200 GeV hadron-beryllium collisions. Bromberg, C.; Fox, G.; Gomez, R.; Pine, J.; Stampke, S.; Yung, K. (California Inst. of Tech., Pasadena (USA)); Erhan, S.; Lorenz, E.; Medinnis, M.; Rohlf, J. *Nucl. Phys., B;* **134**: No. 2, 189-241(13 Mar 1978).

Results from an experiment studying the production of single particles and jets (groups of particles) with high p(transverse) (transverse momentum) in 200 GeV/c interactions on a beryllium target are presented. A detailed discussion of the ambiguities is given in the jet definition. The jet and single-particle cross sections have a similar shape, but the jet cross section is over two orders of magnitude larger. The events show evidence for the coplanar structure suggested by constituent models, and the momentum distributions of charged particles give strong support to a simple quark-quark scattering model.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

1844 Electromagnetic form factors of odd-A axially symmetric deformed nuclei. Moya de Guerra, E.; Dieperink, A.E.L. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **18**: No. 4, 1596-1602(Oct 1978).

Expressions for electron scattering form factors for odd-A deformed nuclei are derived by projecting states with definite angular momentum from an axially symmetric intrinsic wave function. Through an expansion of the multipole matrix elements in terms of 1/<J^2/sub y/> both single-particle and collective contributions are taken into account in a systematic way. Selection rules are discussed and some schematic calculations of magnetic form factors are presented for ^{25}Mg and ^{181}Ta.

1845 Electromagnetic transitions between the low-lying levels of ^{21}Ne and their relation to parity mixing of the 2.80-MeV 1/2^{+-} doublet. Millener, D.J.; Warburton, E.K.; Snover, K.A.; von Lintig, R.; Ikossi, P.G. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **18**: No. 4, 1878-1890(Oct 1978).

The presence of a J/sup π/ = 1/2$^+$-1/2$^-$ doublet (ΔE ≅ 8 keV) at 2.80 MeV in ^{21}Ne provides an opportunity to further investigate parity mixing of nuclear states. The parity mixing in ^{21}Ne introduces an irregular M1, E2 admixture into the regular, but highly retarded, E1, M2 decay of the 1/2$^-$ level to the 3/2$^+$ ground state and can be inferred from the interference between these irregular and regular decays. We consider the dependence of possible ^{21}Ne parity-mixing observables on the four electromagnetic matrix elements involved in the transition and also methods for determining these matrix elements. The first step towards a measurement of the M2/E1 mixing ratio is a measurement of the E2/M2 mixing ratio of the 1/2$^-$ → 5/2$^+$ transition in ^{21}Ne and this is carried out using a γ-γ correlation utilizing the ^{18}O(α,n) ^{21}Ne reaction. A large basis SU(3) shell-model calculation is performed to give wave functions for ^{21}Ne (and ^{21}Na) and predictions for the electromagnetic matrix elements relevent to studies of the 1/2^{+-} parity-mixing. The parity-mixing matrix element is calculated using a one-body approximation to the parity nonconserving interaction. The calculated matrix elements are compared with the available experimental data on ^{21}Ne and ^{21}Na.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1844, 2104

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1832

1846 Average lifetimes of collective transitions in the spin-(30—50) region. Huebel, H.; Smilansky, U.; Diamond, R.M.; Stephens, F.S.; Herskind, B. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **41**: No. 12, 791-794(18 Sep 1978).

A method is developed to determine average lifetimes of continuum gamma rays following heavy-ion compound-nucleus reactions. The resulting enhancement factors for E2 transitions depopulating states in the spin- (30—50) regions are of the same order of magnitude as for ground-state rotational bands of deformed nuclei. This shows for the first time that these high-spin states decay through strongly collective bands.

1847 Possible compound-nucleus formation in back-angle inelastic α-particle scattering. Da Hsuan Feng; Eidson, W.W.; Kollarits, R.V. (Drexel Univ., Philadelphia, Pa. (USA)); Foster, C.C.; O'Fallon, N.M.; Gronemeyer, S.A. (Missouri Univ., St. Louis (USA)); Fulmer, C.B.; Hensley, D.C. (Oak Ridge National Lab., Tenn. (USA)). *Lett. Nuovo Cim.;* **21**: No. 6, 195-200(11 Feb 1978).

A test of the effect of non-energy-averaging compound nucleus formation in large-angle scattering is made. To this end, the differential cross sections are measured of large-angle α-particle inelastic scattering to the 5.24-MeV unnatural-parity state of ^{24}Mg. Parity conservation eliminates any simple direct reaction mecha-

nisms. Even without energy averaging, the data are well fitted by the previously established modified Hauser-Feshbach theory. This non-energy-averaging procedure seems to be able to provide quantitative information regarding the compound nucleus contribution of other channels.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

REFER ALSO TO CITATION(S) 1836, 2104

ENERGY LEVELS AND TRANSITIONS

1848 Population of the 1^+ levels in ^{58}Co via the ^{58}Fe(p, n) reaction. Wong, C.; Bloom, S.D.; Grimes, S.M.; Hausman, R.F. Jr.; Madsen, V.A. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **18**: No. 5, 2052-2060(Nov 1978).

Using time-of-flight techniques in conjunction with a 29.6-m flight path at 0°, the population of 1^+ levels in the ^{58}Fe(p,n) reaction has been investigated at 20.2-MeV bombarding energy. The measured (p,n) 1^+ strength distribution is different from that seen in ^{58}Ni(t,^{3}He) ^{58}Co but similar to that seen in ^{58}Ni(e,e') for populating the T/sup greater-than/ 1^+ analog states. Shell model calculations give a fair description of the (p,n) 1^+ strengths. The (t,^{3}He) and (e,e') 1^+ calculated strengths (identical using our model) do not agree with either the (t,^{3}He) or (e,e') measured strengths. The indications are that 4p-2h structure for both the ^{58}Ni ground state and the 1^+, T = 2 states is necessary to explain the measured (e,e') strengths. This is supported by our shell model calculations, which show that the low-lying parent 1^+ levels in ^{58}Co are predominantly 4p-2h in structure with the four particles in the p3/2-p1/2 orbits, contrary to the simplest assumption of 3p-1h structure with at least one particle in the f5/2 orbit. The fact that (e,e') and (t,^{3}He) 1^+ strengths differ experimentally may be due to two-step processes contributing to the (t,^{3}He) reaction.

1849 Properties of high spin states in the (πf/sub 7/2/)/sup plus-or-minus3/ nuclei ^{51}V and ^{53}Mn. Lister, C.J.; Olness, J.W.; Johnstone, I.P. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **18**: No. 5, 2169-2178(Nov 1978).

The ^{48}Ca(^{10}B,α3n)^{51}V and ^{48}Ca(^{10}B,5n) ^{53}Mn reactions have been used to populate high spin states in ^{51}V and ^{53}Mn. New levels were observed at 7335 keV in ^{51}V, with a probable spin of J = 23/2 and at 5614, 6533, 7004, and 7965 keV in ^{53}Mn with a probable spin sequenceof J = 19/2, 21/2, 23/2, and 25/2, respectively. The Doppler shift attenuation method was used to measure the mean lifetimes of four levels in ^{51}V and three in ^{53}Mn. The high spin states were found to decay predominantly by M1 transitions, while competing E2 decays were not significantly enhanced, revealing no evidence of any collective deformation. Shell model calculations of 1p6h states in ^{51}V and 1p4h states in ^{53}Mn were found to indicate that these excited states are based mainly on neutron excitation from the f/sub 7/2/ shell. The calculations reproduced both the positions of the yrast energy levels and their electromagnetic decays.

1850 Energy levels in ^{57}Ni from a study of the ^{59}Ni(p,t) ^{57}Ni reaction. Nann, H.; Saha, A.; Raman, S. (Cyclotron Laboratory and Department of Physics, Michigan State University, East Lansing, Michigan 48224). *Phys. Rev., C;* **18**: No. 4, 1619-1625(Oct 1978).

Energy levels in ^{57}Ni up to an excitation energy of 9 MeV have been studied by the ^{59}Ni(p,t)^{57}Ni reaction at 40 MeV bombarding energy. An energy resolution of 10—15 keV for the triton groups permitted the identification of about 50 new levels. Unambiguous spin and parity assignments of $3/2^-$ are made to the levels at 0.00, 3.01, 4.92, and 5.19 MeV on the basis of an L = 0 admixture in the angular distributions. Values of the orbital angular momentum L transferred to several states have been deduced.

1851 Yrast decay schemes from heavy-ion + ^{48}Ca fusion-evaporation reactions: IV: ^{53}Cr, ^{54}V, ^{62}Co, and /sup 61hyphen63/Ni. Warburton, E.K.; Olness, J.W.; Nathan, A.M.; Poletti, A.R. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **18**: No. 4, 1637-1650(Oct 1978).

Fusion-evaporation reactions induced by beams of 25—55 MeV ^{9}Be and ^{18}O on an isotopically enriched ^{48}Ca target have been used to populate high-spin yrast levels in ^{53}Cr, ^{54}V, ^{62}Co, and /sup 61hyphen63/Ni. Measurements consisted of γ-ray excitation functions, angular distributions, γ-γ coincidences, and recoil-distance and Doppler shift lifetime measurements, from which were deduced the energy levels, γ-ray branching ratios, most probable spin-parity assignments, and level lifetimes.

1852 Forbidden transitions in the ^{40}Ca(^{15}N,^{16}O)^{39}K reaction and the L = 1 problem. Kubono, S.; Tripp, S.J.; Dehnhard, D.; Udagawa, T.; Tamura, T. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **18**: No. 4, 1929-1933(Oct 1978).

Cross sections of the ^{40}Ca(^{15}N,^{16}O)^{39}K reaction were measured and analyzed. The transition of the $9/2^-$ state, which is of weak-coupling nature, is shown to provide an excellent test of coupled-channel Born-approximation theory and the coupled-channel Born-approximation theory analysis for the L = 1 problem in the ^{40}Ca(^{13}C,^{14}N reaction. Calculated two-step contributions to the L = 1 transitions in the (^{15}N,^{16}O) reaction are large enough to affect the phases of their angular distributions.

1853 New probe of line broadening with resolvable fine structure: The "off-diagonal strength function". Lane, A.M.; Dittrich, T.R.; Mitchell, G.E.; Bilpuch, E.G. (Atomic Energy Establishment, Harwell, Oxfordshire, England). *Phys. Rev. Lett.;* **41**: No. 7, 454-457(14 Aug 1978).

A recently developed technique enables one to measure the relative sign of inelastic proton-channel amplitudes of resonances. Using this we have measured signs of 32 fine-structure levels in the vicinity of the $3/2^-$ analog state seen in the reaction ^{44}Ca + p at E/ sub p/ = 2.6 MeV. Thereby we construct a new type of datum, "the off-diagonal strength function," and compare this with the prediction made by the theory of analog-state broadening. This prediction involves no unknown parameters, and so the degree of fit provides an excellent test of the theory.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1721, 1840, 1851

1854 Neutron capture cross section of manganese. Garg, J.B.; Macklin, R.L.; Halperin, J. (State University of New York at Albany, Albany, New York 12222). *Phys. Rev., C;* **18**: No. 5, 2079-2091(Nov 1978).

Total neutron capture cross section measurements have been carried out for ^{55}Mn (I = 5/2) over the energy interval of 2.5—600 keV. Using time-of-flight techniques and a nonhydrogenous liquid scintillator detector system, resonance energies and capture area were determined for some 143 resonances to 112 keV neutron energy. Values of radiation widths (Γ/sub γ/) were evaluated for broad l = 0 resonances using published total cross section data. Although values of Γ/sub γ/ vary widely for individual resonances, mean values of $<\Gamma$/sub γ/$>$/sub l/ = 0 = 750 +- 150 and $<\Gamma$/ sub γ/$>$/sub iltsts1/ = 400 +- 100 MeV were determined. The correlation between Γ/sub γ/ and Γ/sub n/° (for s-wave resonances) was found to give rho = 0.64 +- 0.14 which is statistically significant at the 99.9% confidence level.

1855 Elastic excitation function of ^{12}C on ^{40}Ca at 180°. Renner, T.R.; Schiffer, J.P.; Horn, D.; Ball, G.C.; Davies, W.G. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **18**: No. 4, 1927-1928(Oct 1978).

An excitation function of elastically scattered ^{12}C from ^{40}Ca at θ/sub c.m./ = 180° was measured at 10 center-of-mass energies between 30.0 and 34.2 MeV to observe whether the anomalous structure that was seen in the back-angle excitation function of ^{12}C and ^{16}O on ^{28}Si also existed in this system. The cross section is $\sim 10^{-4}$ times that for Rutherford scattering, which is about two orders of magnitude lower than was seen with ^{28}Si. A resonance-like energy dependence was observed.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

1856 Mass and low-lying energy levels of ^{69}Cu. Zeidman, B.; Nolen, J.A. Jr. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **18**: No. 5, 2122-2126(Nov 1978).

The (d,^{3}He) reaction on /sup 64,66,68,70/Zn was investigated at E/sub d/ = 23.3 MeV and angular distributions measured for low-lying states. The mass excess of ^{69}Cu is found to be - 65.75 +- 0.01 MeV, about 190 keV less stable than tabulated mass values. A partial level scheme for ^{69}Cu based on the systematics of the (d,^{3}He) reaction and the energy levels of the lighter odd mass Cu isotopes is suggested. Spectroscopic factors for proton pickup from the zinc isotopes are also presented.

RADIOACTIVE DECAY

1857 (AERE-R—8903) **Radioactive-nuclide decay data for reactor calculations. Activation products and related isotopes.** Nichols, A.L. (UKAEA, Harwell. Atomic Energy Research Establishment). Sep 1977. 235p. Dep. NTIS (US Sales Only), PC A11/MF A01.

An evaluation has been made of the decay data of 91 activation products and related nuclides. The resultant recommended data have been produced in ENDF/B-IV format for use in reactor

calculation codes. The data include half-life, branching ratios, alpha, beta and gamma radiation energies and intensities, total decay energy, mean alpha, beta and gamma energies, internal conversion coefficients and associated uncertainties. Conversion electron, Auger electron, x-ray and internal bremsstrahlung data are also included. The alpha, beta and gamma radiation intensities are given as fractions, and all such data are the best estimate of the decay mode intensity per disintegration. In this report the data are presented in a clear form by means of an intermediary listing program.

1858 Decay energies of gaseous fission products and their daughters for A = 88 to 93 and A = 138 to 142. Wohn, F.K.; Talbert, W.L. Jr. (Ames Laboratory-U.S. Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., C;* **18**: No. 5, 2328-2332(Nov 1978).

Decay energies for several mass-separated activities of Kr, Xe, and daughters have been reported previously. At the time of these measurements, the plastic scintillation detector used could be calibrated accurately only to 5 MeV. Using recently available decay energies for Rb and Cs fission products, the calibration curve for β energies above 5 MeV has been redetermined. Redetermined Q/sub β/ values are reported for 23 fission products, and comparison is made with various atomic mass predictions.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 1856

1859 Linear polarization measurements of γ rays from ^{64}Zn. Wells, J.C. Jr.; Robinson, R.L.; Kim, H.J.; Sayer, R.O.; Caffrey, A.J.; Piercey, R.B. (Physics Department, Tennessee Technological University, Cookeville, Tennessee 38501). *Phys. Rev., C;* **18**: No. 5, 2162-2168(Nov 1978).

The linear polarizations of ^{64}Zn γ rays, produced in the ^{59}Co(^{7}Li,2n) reaction with E/sub 7Li/ = 18 MeV, have been measured with a Ge(Li) two-crystal Compton polarimeter. These polarization values were used with previously obtained γ-ray angular distribution measurements to make unique parity assignments for several states. The 641- and 1619-keV γ rays have been found to be predominantly E1 transitions, and odd parity has been assigned to the levels at 2999 keV (3$^-$), 3925 keV (5$^-$), 4635 keV (7$^-$), 4981 keV (7$^-$), and 5681 keV (8$^-$). Even parity assignments have been confirmed for levels at 991 keV (2$^+$), 2736 keV (4$^+$), 3994 keV (6$^+$), and 4237 keV (6$^+$). Also, the spin assignments for levels at 2307 keV (4$^+$) and 4635 keV (7$^-$) have been confirmed.

1860 New results with ^{73}Ge: dispersive interference effects and the 13.3 keV Moessbauer resonance at natural linewidth. Pfeiffer, L. (Bell Labs., Murray Hill, NJ). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 23-26(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Lithium-drifted silicon and intrinsic germanium detectors are compared as detectors for the recoilless γ-rays from ^{73}Ge at 13.3 keV. Use of germanium detector results in improved background rejection and allows one to observe large Moessbauer resonance effects. The unbroadened Moessbauer resonance from the 13.3 keV level of ^{73}Ge is observed. The resonances all show a dispersive lineshape asymmetry due to final state interference effects between photoelectric absorption and Moessbauer absorption followed by internal conversion.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1832

1861 Spallation of Cu by 500- and 1570-MeV π^-. Haustein, P.E.; Ruth, T.J. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **18**: No. 5, 2241-2251(Nov 1978).

Relative yields of 36 products extending from ^{7}Be to ^{65}Zn have been measured for the interaction of 500- and 1570-MeV negative pions with Cu. These results are compared with calculations from the ISOBAR model, with earlier studies of Cu spallation with lower (resonance) energy pions, energetic protons, and heavy ions. Relative yield patterns at both π^- energies show only slight differences when compared to spallation by protons of comparable energy. Calculations from the ISOBAR model adequately reproduce the shapes of the mass yield and charge yield of the experimental data for 500-MeV π^-. The calculation, however, overestimates the yield of neutron-rich isotopes from deep spallation. At the 1570-MeV π^- energy the yield patterns, charge-dispersion, and mass-yield curves are nearly identical to those for 2-GeV proton spallation. These results suggest that pion-nucleon resonance effects probably decrease at higher energies and that limiting fragmentation and factorization concepts may be applied to understanding high-energy pion spallation.

1862 Sequential amplitudes in heavy-ion induced two-proton transfer reactions. Tung, P.P.; Erb, K.A.; Sachs, M.W.; Sherwood, G.B.; Ascuitto, R.J.; Bromley, D.A. (A. W. Wright Nuclear Structure Laboratory, Physics Department, Yale University, New Haven, Connecticut 06520). *Phys. Rev., C;* **18**: No. 4, 1663-1676(Oct 1978).

Angular distributions have been measured for the reactions ^{88}Sr(^{16}O,^{14}C)^{90}Zr and ^{90}Zr(^{16}O,^{14}C)^{92} Mo at 80 MeV, and ^{88}Sr(^{12}C,^{10}Be)^{90}Zr and ^{90}Zr(^{12}C,^{10}Be)^{92}Mo at 60 MeV. The data were analyzed with full recoil, coupled-channel Born approximation calculations, in which both direct (one-step) and sequential (two-step) reaction routes were considered. Detailed shell model wave functions were used to construct all form factors. The calculated sequential contributions to the cross sections were found to be significantly larger than those associated with direct transfer, and inclusion of the two-step routes substantially improved agreement with experiment. The calculated angular distribution shapes were found to depend on both the intermediate Q value of the sequential process, and also on the microscopic configurations involved in the transfer. In addition, a previously unreported configuration dependence of the recoil corrections was noted in he calculations.

1863 Isospin splitting of giant dipole resonance and the cross section of the reaction ^{64}Zn(γ,n)^{63}Zn. Verbitskii, S.S.; Lapik, A.M.; Ratner, B.S.; Sergievskii, A.N. (Institute of Nuclear Research, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 294-297(5 Mar 1978).

The cross section of the reaction ^{64}Zn(γ, n)^{63}Zn was investigated for the high-energy component of the neutron spectrum (ϵ/sub n/> or =3.7 MeV). An analysis of the results indicates that the interpretation of the structure observed in the cross section of the ^{64}Zn(γ, n)^{63}Zn as a manifestation of isospin splitting is in error.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

1864 Identification of the lowest 3$^-$ collective level in ^{116}Cd. Hansen, L.F.; Dietrich, F.S.; Koopman, R.P. (Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **18**: No. 4, 1582-1586(Oct 1978).

γ rays from the ^{116}Cd(p,p'γ) reaction have been measured with a Ge(Li) detector from E/sub p/ = 5 to 20 MeV, and excitation functions of the decays of the 1917-, 1923-, and 1930-keV triplet to the 513-keV 2$^+$ level have been extracted. Only the decay of the 1923-keV level has an excitation function consistent with a component predicted by a coupled-channel calculation for the excitation of a 3$^-$ collective level. The sum of the cross sections for the remaining two γ rays is 90% of that for the decay of the 1923-keV level at E/sub p/ = 5 MeV, decreasing to about 20% at 20 MeV.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1836

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 1857, 1858

1865 Energies and intensities of weak transitions in the decay of ^{133}I. Nettles, W.G.; Scoggins, R.K.; James, W.K.; Whitlock, L.C.; Subba RaoD, B.N.; Hamilton, J.H.; Ramayya, A.V.; Gunnink, R. (Physics Department, Mississippi College, Chilton, Mississippi 39058). *Phys. Rev., C;* **18**: No. 5, 2441-2446(Nov 1978).

The γ-ray spectrum of a ^{133}Te-^{133}I equilibrium source was measured with an 18% efficiency Ge(Li) detector to search for weak transitions in the ^{133}I decay. A more detailed study was made of an earlier spectrum taken with a Compton suppression system and a chemically purified source. The results are compared with all available data and average values of the energies and intensities are given.

1866 Systematic study of the structure of odd-mass lanthanum nuclei. III. Levels in ^{133}La from the decay of 5-h ^{133}Ce. Henry, E.A.; Meyer, R.A. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., C;* **18**: No. 4, 1814-1839(Oct 1978).

Levels of ^{133}La populated by the β decay of the 9/2$^-$ 5-h isomer of ^{133}Ce were studied by γ-ray spectroscopy, γ-γ coincidence counting, and conversion-electron spectroscopy of mass-separated ^{133}Ce sources. The ^{133}La level scheme was greatly extended and substantial differences from previous level schemes were found.

Both the observed negative and positive parity levels are accounted for in terms of decoupled band structure by calculations based on thee particle-plus-triaxial-rotor model. Deviations of this simple picture from the experimental data aree discussed.

1867 N = 85 nuclei. II. Decay of 4.15-h ^{149}Tb/sup g/ to levels of ^{149}Gd. Jackson, S.V.; Starner, J.W.; Daniels, W.R.; Bunker, M.E.; Meyer, R.A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **18**: No. 4, 1840-1856(Oct 1978).

The γ-ray spectrum accompanying the decay of 4.15-h ^{149}Tb/sup g/ has been studied by Ge(Li) singles and coincidence spectroscopy. Sources were prepared via the ^{141}Pr(^{12}C,4n) reaction and via spallation of Ta with 800-MeV protons. Chemical and isotropic separation techniques were employed to obtain pure sources. A total of 325 γ rays are attributed to the decay of ^{149}Tb/sup g/, all of which have been placed in a ^{149}Gd level scheme involving 80 excited states. The spin and parity of ^{149}Tb/sup g/ is postulated to be 1/2$^+$. The intensity of the direct β^+ + electron capture branch from ^{149}Tb/sup g/ to the ^{149}Gd ground state (7/2$^-$) is determined to be (0.5 * 5.0) %. The intensity of the α-decay branch from ^{149}Tb/sup g/ to ^{145}Eu has been measured to be (15.8 < +- The observed level structure of ^{149}Gd is discussed in terms of current nuclear models.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 1867

1868 Nuclear data sheets for A-142. Tuli, J.K. (National Nuclear Data Center Brookhaven National Laboratory Upton, New York 11973, USA). *Nucl. Data Sheets;* **25**: No. 1, 53-112(Sep 1978).

Experimental nuclear structure information is presented for all nuclides with mass 142. The data are based on radioactivity as well as nuclear reaction studies. The appropriate comments indicating analysis techniques, assumptions used, and data inconsistencies have been given with each data set.

NUCLEAR REACTIONS AND SCATTERING

1869 (JINR-D—1,2-10400, pp A6.10-A6.11) **Study of the "young" states of particles in p-, d-, and α-nuclei interactions.** Sarycheva, L.I. (Moskovskij Gosudarstvennyj Univ. (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

Experimental data on leading particle generation in p-, d- and α-nuclei interactions are compared with calculations within the framework of a simple classical model of scattering. Data show that deuterons and α-particles in inelastic interactions retain their individuality in some case, even after losing from 10 to 30% of their energy and scattering at considerable angles. Comparison between the experimental data and the calculations made in terms of the simplified model shows that there exists a sufficiently high probability for 8.4 GeV/c deuterons and 16.8 GeV/c α-particles to undergo more than one interaction in the same nuclei.

1870 Effect of nuclear deformation on heavy-ion fusion. Stokstad, R.G.; Eisen, Y.; Kalplanis, S.; Pelte, D.; Smilansky, U.; Tserruya, I. (The Weizmann Institute of Science, Rehovot, Israel). *Phys. Rev. Lett.;* **41**: No. 7, 465-469(14 Aug 1978).

The cross sections for the fusion of ^{16}O with the spherical and deformed isotopes of Sm measured at bombarding energies spanning the fusion barrier indicate the importance of nuclear deformation for the fusion process. Calculations based on the usual static treatment of deformation effects, however, show significant discrepancies with the experimental data.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 1844

1871 Indication for a K/sup π/ = 0$^-$ octupole band in ^{150}Nd from electron scattering. Creswell, C.; Hirsch, A.; Bertozzi, W.; Heisenberg, J.; Kowalski, S.; Sargent, C.P.; Turchinetz, W.; Dieperink, A. (Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **18**: No. 5, 2432-2434(Nov 1978).

Recent electron scattering results on the 0.850 MeV level of ^{150}Nd, when analyzed in terms of the interacting boson model, are inconsistent with the interpretation of this level as a pure J/sup π/ (K) = 2$^+$ (0) state. Very recent (n,n'γ) work has shown this level to be a 1$^-$, 2$^+$ doublet. Assuming this level to be the band head of a "K/sup π/ = 0$^-$" octupole band, a simple model is used to predict electron scattering form factors for the 0.850 MeV state and a 3$^-$ octupole level observed at 0.931 MeV. Comparison is made between these predicted form factors and recent electron scattering data.

1872 Possible manifestations of oblate shapes at high spin in the yrast region of A = 160—180 nuclei. Peker, L.K.; Hamilton, J.H.; Rasmussen, J.O. (Natuurkundig Laboratorium, Vrije Universiteit, Amsterdam, The Netherlands). *Phys. Rev. Lett.;* **41**: No. 7, 457-459(14 Aug 1978).

The possible manifestations of an oblate-shape region at high spin in A = 160—180 nuclei are considered. We focus attention on the fact that rotational band phenomena indeed can exist in nuclei with oblate shapes. From estimates of transition energies, the yrast cascade there could consist largely of low-energy, alternating M1 transitions within bands and E2 transitions between bands. If the recently found stretched-dipole transitions are confirmed as M1, these results may be an indication for the existence of oblate shapes at high spin.

1873 Change of the mean square nuclear charge radius for the 2$^+$-0$^+$ transitions in ^{178}Hf, ^{182}W, and ^{186}Os. Wagner, F.E.; Karger, M.; Seiderer, M.; Wortmann, G. (Technische Universitaet Muenchen, Garching, Ger.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 13-22(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

The change $\Delta(r^2)$ of the mean square nuclear charge radius for the 2$^+$-0$^+$ rotational transitions in ^{178}Hf, ^{182}W, and ^{186}Os was determined from Moessbauer isomer shift data for these isotopes in various cubic transition metal hosts. The results are $\Delta(r^2) = +1 \times 10^{-4}$ fm^2, -3.6×10^{-4} fm^2, and $+2 \times 10^{-4}$ fm^2 for the ^{178}Hf (93kev), ^{182}W (100 keV), and ^{186}Os (137 keV) resonances, respectively.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 1857

ENERGY LEVELS AND TRANSITIONS

1874 Deformation change at N = 89: Proton inelastic scattering at 12 MeV on /sup 151,152,153/Eu. Lanier, R.G.; Mann, L.G.; Struble, G.L.; Proctor, I.D.; Heikkinen, D.W. (Nuclear Chemistry Division, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., C;* **18**: No. 4, 1609-1618(Oct 1978).

Scattered protons from /sup 151,152,153/Eu were measured with an Enge split-pole spectrograph at a bombarding energy of 12 MeV. Rotational states up to I/sup π/ = 7$^-$ were observed in ^{152}Eu. Values of the deformation parameters were extracted from the scattering data using distorted-wave and coupled-channels techniques. The analysis suggests values of β_2 for /sup 151,152,153/Eu to 0.13, 0.28, and 0.28, respectively. For /sup 152,153/Eu β_4 is found to be + 0.06. The data for ^{152}Eu suggest that the low-lying members of the K = 4$^-$, [π3/2(411), ν 11/2(505)] band are populated in the (p,p') reaction. This population is consistent with estimates of the degree of Coriolis mixing of this band with the K = 3$^-$, [π5/2(413), ν11/2(505)] ground band.

1875 Experiments in the accelerator beam: change in the charge radius of 2$^+$ rotational levels. Hanna, S.S. (Stanford Univ., CA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 1-12(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

The method of in-beam implantation is discussed and illustrated by implantation of ^{57}Fe into single crystals of semiconductors. The application to isotopes which cannot be produced by radioactive sources is illustrated by a study of the isomer shifts in isotopic series of rotational nuclei. Spectra obtained for implantation of ^{57}Fe into single crystals of germanium as a function of temperature are shown. Two well defined sites are observed. The right hand resonance can be identified with a substitutional site, while the left hand resonance is produced by either an interstitial or a "damage" site. A series of experiments are considered which illustrate the use of in-beam implantation to produce high-quality, single-line sources of nuclei which cannot be produced by radioactive parents. In particular, these experiments measure the isomer shifts in a complete series of isotopes. Usually only the proton-rich isotopes can be measured with radioactive sources; in-beam implantation can then be used to complete the series. The Gd and Yb series are completed in this way. 10 references. (JFP)

1876 Some recent developments in the ^{181}Ta(6.2 keV)-spectroscopy. Wortmann, G.; Dornow, V.; Heidemann, A.; Trollmann, G. (Technische Universitaet Muenchen, Garching, Ger.). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 39-40(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

The 6.2 keV level of ^{181}Ta($T^1/_2$ = 6.8 μs) belongs to the few Moessbauer resonances with lifetimes in the microsecond region. The corresponding natural linewidth, W_0 = 6.5 μm/s, has not been observed so far. In spite of many efforts, the best experimental linewidths are still a factor of approximately 10 larger than W_0. A new method of source preparation from cyclotron-produced, carrier-free ^{181}W activity, which yields either an improvement in the experimental linewidth or in the source efficiency.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1721

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

MASS, ABUNDANCE, AND BINDING ENERGY

1877 Test of the time-dependent mean-field theory in Kr-induced strongly damped collisions. Davies, K.T.R.; Maruhn-Rezwani, V.; Koonin, S.E.; Negele, J.W. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **41**: No. 9, 632-635(28 Aug 1978).

Axially symmetric time-dependent mean-field calculations using a Skyrme-type effective interaction have been performed for ^{84}Kr + ^{208}Pb at E/sub lab/ = 494 MeV and ^{84}Kr + ^{209}Bi at E/sub lab/ = 600 MeV. Calculated fragment energies, mean masses, and scattering angles for strongly damped collisions are in good agreement with experiment, but mass distribution widths are an order of magnitude too small.

NUCLEAR REACTIONS AND SCATTERING

1878 (UCRL—81498) Direct-semidirect and pure-resonance model calculations of fast neutron capture on ^{208}Pb. Dietrich, F.S.; Kerman, A.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1978. Contract W-7405-ENG-48. 4p. (CONF-780926—1). Dep. NTIS, PC A02/MF A01.

From 3. symposium on neutron capture of gamma-ray spectroscopy; Upton, NY, USA (18 Sep 1978).

Fast neutron capture on ^{208}Pb is calculated in a formalism in which only a giant-dipole resonance term appears explicitly. The calculations give reasonable fits to the data, and are much less sensitive to form-factor ambiguities than direct-semidirect calculations.

1879 Systematics of fusion barriers obtained with a modified proximity potential. Vaz, L.C.; Alexander, J.M. (Departmento de Fisica Nuclear, I.F.U.F.R.J. Cidade Universitaria, Ilha do Fundao, Rio de Janeiro, R. J. Brasil 20.000). *Phys. Rev., C;* **18**: No. 5, 2152-2161(Nov 1978).

A systematic semiempirical analysis is presented for excitation functions for complete fusion of comples nuclei. Barrier penetration is included as is the l dependence of the fusion radius. The general form of the proximity potential is assumed and small but important parameter adjustments are made to achieve a fit to experimental data. A correction is presented of s-wave barrier heights and radii for complete fusion. For Z/sub t/Z/sub p/ 5 500 these fusion radii are greater than the empirical reaction radii obtained at energies well above the barrier. This result implies weak surface absorption for Z/sub t/Z/sub p/ 5 500 and the contrary for higher Z/sub t/Z/sub p/.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

1880 Isomeric states in ^{212}Bi. Baisden, P.A.; Leber, R.E.; Nurmia, M.; Nitschke, J.M.; Michel, M.; Ghiorso, A. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **41**: No. 11, 738-741(11 Sep 1978).

Two new alpha activities with half-lives of 25 and 9 min have been observed in reaction of heavy ion with a variety of heavy targets. The 25-min activity was found by combined radiochemical methods and mass separations to be an isomer in ^{212}Bi; the 9-min activity is also likely to be an isomer in ^{212}Bi.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 1880

1881 Nuclear data sheets for A=201. Schmorak, M.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **25**: No. 1, 193-234(Sep 1978).

Experimental data pertaining to nuclei with A=201 are compiled and evaluated.

1882 Electron scattering of ^{207}Pb and the induced charge of the neutron. Papanicolas, C.N.; Heisenberg, J.; Lichtenstadt, J.; Courtemanche, A.N.; McCarthy, J.S. (Bates Linear Accelerator Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **41**: No. 8, 537-540(21 Aug 1978).

High-resolution inelastic electron-scattering cross sections from ^{207}Pb have been measured in the range of momentum transfer 0.37 fm^{-1} < or = q < or = 2.30 fm^{-1}. Form factors have been extracted for low-lying neutron hole states and some-particle, two-hole states. Models for the induced charge of the neutron are compared with the data.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 1832

1883 Emission of ^{24}Na fragments in the interaction of ^{197}Au with intermediate-energy pions and protons. Porile, N.T.; Dropesky, B.J.; Williams, R.A. (Department of Chemistry, Purdue University, West Lafayette, Indiana 47907). *Phys. Rev., C;* **18**: No. 5, 2231-2240(Nov 1978).

Excitation functions for the formation of ^{24}Na from ^{197}Au have been measured for incident π^+ between 176 and 368 MeV, π^- between 239 and 368 MeV, and protons between 197 and 800 MeV. The cross sections increase sharply with energy and at any given energy obey the relation σ/sub pi+/ > σ/sub pi-/ > σ/sub p/. The results are analyzed in terms of the contribution of hot-spot and coherent-cascade mechanisms to the proton yields. The role of statistical phase-space factors, as embodied in cascade-evaporation calculations, is invoked to explain the ratio of π^+ and π^- cross sections.

SPONTANEOUS AND INDUCED FISSION

1884 Nucleons lost by uranium and bismuth nuclei in high-energy fission. Shashmin, V.E.; Andronenko, M.N.; Sinogeev, I.N.; Solyakin, G.E.; Trush, S.T.; Chestnov, Y.A. (B. P. Konstantinov Nuclear Physics Institute of the USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 288-290(5 Mar 1978).

We measured the masses of the correlated fission fragments of the nuclei ^{238}U and ^{209}Bi by protons with E/sub p/=1000 MeV. We obtain, for the first time ever, the experimental distribution of the sums of the fragment masses, which made it possible to determine the total nucleon losses before and after the instant of scission.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

1885 (COO—2479-14) Measurement of the ^{238}U (eta,γ) cross section with an Fe-filtered neutron beam. Quan, B.L.; Block, R.C. (Rensselaer Polytechnic Inst., Troy, NY (USA). Gaerttner LINAC Lab.). 1978. Contract EY-76-S-02-2479. 20p. (CONF-780921—1). Dep. NTIS, PC A02/MF A01.

From Conference on neutron physics and other applied purposes; Harwell, UK (25 Sep 1978).

The neutron capture cross section of ^{238}U was measured near 24.3, 69.8, 80.3, 131.0, 165.9 and 181.4 keV with the Fe-filtered neutron time-of-flight technique. The measured capture cross sections at these energies are respectively (496 +- 15), (297 +- 22), (190 +- 9), (167 +- 6), (128 +- 7), and (118 +- 6) mb. The evaluated ENDF/B-IV capture cross section is in satisfactory agreement with the results of this measurement near 24.3 and 131.0 keV, but discrepancies of about 10 to 20 percent are observed at the other energies.

SPONTANEOUS AND INDUCED FISSION

1886 Relative thresholds for production of iodine isotopes from fusion and transfer-induced fission reactions. de Saint-Simon, M.; Otto, R.J.; Seaborg, G.T. (Laboratorie Rene Bernas, BP1, 91406 Orsay, France). *Phys. Rev., C;* **18**: No. 4, 1651-1662(Oct 1978).

The reaction of ^{40}Ar ions with energies from 212 to 340 MeV impinging on a thick ^{238}U target has been studied using radiochemical methods. The formation cross sections of iodine isotopes were

measured and converted to independent yields from which isotopic distributions were derived. The observed shape of the iodine distributions is attributed to entrance channel mechanisms: quasielastic transfer, deep inelastic transfer, and complete fusion, each followed by fission. The width and shape of the complete fusion component are found to be consistent with the statistical model for fission and a standard evaporation code for the fragment deexcitation. The threshold for production of iodine isotopes by the complete fusion reaction is found to be at least 8 to 12 MeV higher in energy than the barrier for the production of iodine isotopes by the quasielastic transfer reaction. These barriers are compared with theoretical predictions.

1887 Fast neutron fission of ^{240}Pu. Myers, W.A.; Kantelo, M.V.; Osborne, R.L.; Prindle, A.L.; Nethaway, D.R. (McClellan Central Laboratory, 1155th Technical Operations Squadron, McClellan AFB, California 95652). *Phys. Rev., C;* **18**: No. 4, 1700-1705(Oct 1978).

We have measured the mass-yield distribution from the fission of ^{240}Pu induced by fast neutrons from a plutonium metal critical assembly. Measurements were made for 44 fission products from ^{72}Zn to ^{169}Er, from which we calculated total chain yields for 36 mass numbers and constructed a mass-yield curve. Absolute fission yields were obtained with an accuracy of about 5% by using the ^{235}U (n,f) monitor reaction and by the requirement of unit total yield in each half of the mass-yield distribution. The peak-to-valley ratio is about 150. Several independent fission yields were measured and Z/ sub p/ values inferred from these measurements are in good agreement with those estimated from independent-yield systematics.

NUCLEAR THEORY

NUCLEAR STRUCTURE

REFER ALSO TO CITATION(S) 1817

1888 (CONF-780693—1) **Shell model tests of the interacting boson model description of nuclear collective motion.** McGrory, J.B. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From Workshop on interacting boson model; Erice, Italy (5 Jun 1978).

The results of a large shell-model calculation of a pseudonucleus which displays striking behavior suggestive of rotational phenomena are presented. In these calculations, a specific and physically reasonable single-particle structure is given to the wave functions, and an explicit two-body residual interaction is used. The calculations show the coupling of key low-lying neutron and proton states of valence particles can lead to collective rotational features which appear to be more distinct and which extend to higher angular momenta as the number of particles increases and that those states which are rotational are dominated by states formed by coupling $J = 0$ and $J = 2$ two-particle states. Considerable supporting evidence is offered for the validity of the assumptions of the interacting boson model. 2 references. (JFP)

1889 Time-dependent coupled-cluster approximation to nuclear dynamics. I. Application to a solvable model. Hoodbhoy, P.; Negele, J.W. (Center for Theoretical Physics, Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **18**: No. 5, 2380-2394(Nov 1978).

A general hierarchy of approximations to the many-body Schroedinger equation is presented which reduces to the time-dependent mean-field approximation in lowest order and provides systematic corrections in subsequent orders. The theory is applied to two interacting systems described by the Lipkin model Hamiltonian. Comparison of the results of the lowest two orders of approximation with the exact solution demonstrates the practicality of the method and its potential for generalizing nuclear dynamics beyond the mean field theory.

1890 Shell-model tests of the interacting-boson—model description of nuclear collective motion. McGrory, J.B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **41**: No. 8, 533-536(21 Aug 1978).

Large shell-model calculations have been made of a pseudonucleus to see (1) what collective features appear and (2) what the resulting collective wave functions consistent with the assumption of the interacting-boson model are. In the calculations, sets of states with striking similarity to states in $K = 0$ and $K = 2$ rigid-rotor bands appear. For the $K = 0$ bands, the the lower states are dominated by states formed from coupling $J = 0$ and $J = 2$ two-neutron ad two-proton states, consistent with the assumptions of the interacting-boson model.

NUCLEAR MATTER

1891 Current state of nuclear matter calculations. Day, B.D. (Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Mod. Phys.;* **50**: No. 3, 495-521(Jul 1978).

The current state of nuclear matter calculations is described with special reference to the present disagreement between the variational and Brueckner—Bethe methods. The system is assumed to consist of point nucleons with a nonrelativistic Hamiltonian containing the kinetic energy and two-body potentials. The physical ideas of the variational method, especially of its hypernetted-chain version, and of the Brueckner: Bethe method are outlined. Practical ways of testing the validity of these mehtods are discussed and are illustrated by numerical results taken from the literature. It is found for central forces that the hypernetted-chain variational method, if properly used, gives reliable upper bounds to the ground-state energy. Lowest-order Brueckner—Bethe results lie well above these upper bounds, and it is both important and feasible to check whether higher-order corrections will bring the Brueckner—Bethe results into agreement with the variational ones. For realistic nuclear potentials, which have tensor forces, spin—orbit forces, etc., the situation is much less clear. An adequate calculation has not yet been done by either the variational or Brueckner—Bethe method. For the Reid potential, with the presently available numerical results, the variational calculation predicts a much higher saturation density than the Brueckner—Bethe calculation. Feasible calculations that will help to resolve this discrepancy are discussed.

NUCLEAR REACTIONS AND SCATTERING

1892 (JINR-D—1,2-10400, pp A6.12-A6.15) **Mechanisms of the cumulative hadron production on nuclei.** Efremov, A.V. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1977.

From 18. international conference on high energy physics; Tbilisi, USSR (15 Jul 1976).

In Proceedings of the 18. international conference on high energy physics. Vol. 1.

The peculiarities of the cumulative hadron production on nuclei are considered. The mechanisms proposed for explanation of these phenomena can be subdivided into three groups: the Fermi motion inside a nucleus, the multiple scattering with nucleons of nucleus and inelastic scattering with a coherent "fluction" (a fluctuation of the nuclear matter inside a nucleus). The Fermi motion and multiple scattering cannot explain all the features. The most promising seems to be the coherent "fluction" mechanism.

1893 (LA-UR—78-1665) **Introduction to multiple scattering and the pion nucleus optical potential.** Gibbs, W.R. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 10p. Dep. NTIS, PC A02/MF A01.

Starting from the Schroedinger equations a brief introduction to t-matrices, multiple scattering and applications to the pion-nucleus scattering is given.

1894 (LA-UR—78-1666) **Fixed nucleon approximation.** Gibbs, W.R. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 23p. Dep. NTIS, PC A02/MF A01.

A review of recent work and techniques in multiple scattering using the fixed nucleon approximation is given. Applications to elastic scattering and single charge exchange are illustrated.

1895 Statistics of the fireball model. Mantzouranis, G. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., C;* **18**: No. 5, 2227-2230(Nov 1978).

We derive the fireball model using a parametrization of the exact S matrix. It will be shown that the fireball model is related to the normal distribution of the parameters in the S-matrix expansion. This way the fireball will be understood in the same frame as the usual statistical spectrascopy.

1896 Relation between the nuclear dynamics and the renormalization group. Mantzouranis, G. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., C;* **18**: No. 5, 2324-2327(Nov 1978).

We present a possible connection of a recent model for the nuclear motion with the renormalization group. We focus our attention on quantities which depend on the bulk properties of the two-body potential.

1897 Adiabaticity of time-dependent Hartree-Fock solutions. Bonche, P.; Quentin, P. (W. K. Kellogg Radiation Laboratory, California Institute of Technology, Pasadena, California 91125). *Phys. Rev., C;* **18**: No. 4, 1891-1905(Oct 1978).

A tractable method is presented for the study of the adiabaticity of a given time-dependent Hartree-Fock solution. In terms of the Baranger-Veneroni approach, this amounts to extracting the two operators ρ_0 and χ, for which rather simple expressions are derived. These explicit formulas are exploited to illustrate some

implications of the adiabatic approximation itself and several related approximations. In particular, the compatibility of two current hypotheses for the chi operator (locality and absence of particle-particle, hole-hole matrix elements) is pointed out. Finally, the whole disucssion is exemplified by the simple case of uniform translational motion.

1898 **Nuclear vertex constants.** Blokhintsev, L.D.; Borbely, I.; Dolinskii, E.I. (Nuclear Physics Research Institute, M. V. Lomonosov Moscow State University, Moscow). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 6, 485-511(Nov 1977).

The properties of the nuclear vertex constants, the relations between them and the nuclear wave functions and other quantities, and also their values for some light nuclei are reviewed.

NUCLEAR MOMENTS AND SPIN

1899 **Influence of rotation on the collective properties of nuclei.** Mikhailov, I.N.; Neergard, K.; Pashkevich, V.V.; Frauendorf, S. (Joint Institute for Nuclear Research, Dubna). *Sov. J. Particles Nucl. (Engl. Transl.);* **8**: No. 6, 550-581(Nov 1977).

An attempt is made to give a fairly complete description of the theoretical and experimental investigations into the influence of rotation on the collective properties of nuclei. Attention is centered on the angular-momentum dependence of the correlation properties of the superconducting type, the deformation parameters, and the electrical properties of nuclei. Also considered are the influence of rotation on the volume, the momentum distribution of the nucleons, the spin polarization in the nuclei, and phenomena related to these effects.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 1897

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 1904

1900 (CONF-780534—5) **Spatial correlation of energy deposition events in irradiated liquid water.** Hamm, R.N.; Wright, H.A.; Turner, J.E.; Ritchie, R.H. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

From 6. symposium on microdosimetry; Brussels, Belgium (May 1978).

Monte Carlo electron transport computer code is used to study in detail the slowing down of electrons and all of their secondaries with initial energies up to 1.5 MeV in liquid water. The probability distributions for the number of ionizations and for the energy deposited in cubical volume elements from electron tracks in the water are analyzed. Both the electron energies and the sizes of the cubical cells are varied. Results are shown for electron energies between 100 eV and 10 keV and for cell sizes between 40 A and 1500 A. Good general agreement is found with results presented by Paretzke at the last symposium. The code can be used to obtain other basic distributions of importance in microdosimetry. As an example, microdosimetric single-event spectra for 500-eV electrons are computed in cubes with edges that range in size from 40 A to 200 A. The importance of correlations is shown explicitly in a comparison of secondary electrons produced by ^{60}Co and 50-keV photons.

1901 (LBL—6721) **Neutron flux density and secondary-particle energy spectra at the 184-inch synchrocyclotron medical facility.** Smith, A.R.; Schimmerling, W.; Henson, A.M.; Kanstein, L.L.; McCaslin, J.B.; Stephens, L.D.; Thomas, R.H.; Ozawa, J.; Yeater, F.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1978. Contract W-7405-ENG-48. 78p. Dep. NTIS, PC A05/MF A01.

Helium ions, with an energy of 920 MeV, produced by the 184-inch synchrocyclotron of the Lawrence Berkeley Laboratory are now being used in a pilot series to determine their efficacy in the treatment of tumors of large volume. The techniques for production of the large uniform radiation fields required for these treatments involve the use of beam-limiting collimators and energy degraders. Interaction of the primary beam with these beam components produces secondary charged particles and neutrons. The sources of neutron production in the beam transport system of the alpha-particle beam have been identified and their magnitudes have been determined. Measurements with activation detectors and pulse counters of differing energy responses have been used to determine secondary particle spectra at various locations on the patient table. These spectra are compared to a calculation of neutron production based on best estimates derived from published cross sections. Agreement between the calculated spectra and those derived from experimental measurements is obtained (at the 10 to 20% level) when the presence of charged particles is taken into account. The adsorbed dose in soft tissue is not very sensitive to the shape of the incident neutron energy spectrum, and the values obtained from unfolding the experimental measurements agree with the values obtained from the calculated spectra within the estimated uncertainty of +-25%. These values are about 3 x 10^{-3} rad on the beam axis and about 1 x 10^{-3} rad at 20 cm or more from the beam axis, per rad deposited by the incident alpha-particle beam. Estimates of upper limit dose to the lens of the eye and red bone marrow are approximately 10 rad and approximately 1 rad, respectively, for a typical treatment plan. The absorbed dose to the lens of the eye is thus well below the threshold value for cataractogenesis estimated for fission neutrons. An upper limit for the risk of leukemia is estimated to be approximately 0.04%.

1902 (UCID—17869) **Preliminary evaluation of a spherical bragg x-ray crystal.** Koppel, L.N.; Knight, L.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Jul 1978. Contract W-7405-ENG-48. 8p. Dep. NTIS, PC A02/MF A01.

Recently, preliminary measurements were taken to demonstrate the quality of narrow spectral band, two-dimensional imaging of a specially-shaped quartz x-ray diffracting crystal. The evaluation consisted of back-illuminating a fine wire mesh, located off the focal circle of the crystal, with a monochrome of aluminum K radiation and observing the quality of the grid-shadowed pattern diffracted by the crystal. The experiment was performed in a vacuum diffractometer. While the actual spatial resolution limit of the crystal was not measured, this limit is demonstrated to be significantly less than 50 microns.

NEUTRON INTERACTIONS WITH MATTER

1903 (ORNL/TM—6401) **Nuclear accident dosimetry: calculations and comparison with experimental data.** Santoro, R.T.; Alsmiller, R.G. Jr.; Barnes, J.M. (Oak Ridge National Lab., TN (USA)). Jul 1978. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

Calculated results, carried out by the method of discrete ordinates, of the absorbed dose received by personnel at various locations relative to the source in a simulated reactor criticality accident are presented and compared with experimental data. The geometry of the room in which the "accident" took place is included approximately in the calculations. The calculated and experimental data are in good agreement in all cases.

1904 (TID—28576) **AMPX: a modular system for multigroup cross-section generation and manipulation.** Greene, N.M.; Ford, W.E. III; Petrie, L.M.; Diggs, B.R.; Webster, C.C.; Lucius, J.L.; White, J.E.; Wright, R.Q.; Westfall, R.M. (Union Carbide Corp., Oak Ridge, TN (USA). Computer Sciences Div.). 1977. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

The AMPX system, developed at the Oak Ridge National Laboratory over the past seven years, is a collection of computer programs in a modular arrangement. Starting with ENDF-formatted nuclear data files, the system includes a full range of features needed to produce and use multigroup neutron, gamma-ray production, and gamma-ray interaction cross-section data. The balance between production and analysis is roughly even; thus, the system serves a wide variety of needs. The modularity is particularly attractive, since it allows the user to choose an arbitrary execution sequence from the approximately 40 to 50 modules available in the system. The modularity also allows selection from different treatments; e.g., the Nordheim method, a full blown integral transport calculation, the Bondarenko method, or other alternatives can be selected for resonance shielding.

1905 **Transport equation with anisotropic scattering in finite slab geometry.** Gibbs, A.G.; Seto, R. (Battelle, Pacific Northwest Laboratory, Richland, Washington 99352). *J. Math. Phys. (N.Y.);* **19**: No. 12, 2591-2604(Dec 1978).

We consider one-speed neutron transport or monochromatic radiative transfer in a slab of finite width, with particles incident on both faces. The scattering kernel is represented as a finite sum of Legendre polynomials. An exact expression is obtained for the expansion coefficients of the flux in a singular eigenfunction representation. It involves the X and Y functions of Chandrasekhar and the q/sub l/ and s/sub l/ polynomials of Sobolev. Case's full- and half-range expansions are obtained as limits when the slab thickness becomes zero or infinite, respectively. Orthogonality relations for the singular eigenfunctions and their adjoints are given. Also, we derive a number of orthogonality relations of the Inoenue-type involving moments of the eigenfunctions. Expressions for surface densities, currents, and higher order Legendre moments of the surface fluxes are obtained. Singular integral transform relations between the Chandrasekhar phi and psi functions and the polynomials g/sub l/(ν), are given. Also, we give the solution of slab prob-

lems with one face having diffuse or specular reflecting boundary conditions.

MEDICAL PHYSICS

RADIATION PROTECTION STANDARDS

1906 Radiation exposure and protection problems in nuclear power plants. US overview. Verna, B.J. (Nuclear Power Experience, Inc., Encino, Calif. (USA)). *Atomkernenergie;* **30**: No. 4, 282-286(1977).

From 5. International Reactor Shielding Conference; Knoxville, TN, USA (18 - 22 Apr 1977).

The author expresses a concern that situations may occur where plants could not obtain sufficient maintenance personnel with unused exposure possibilities to complete repair efforts. The restrictions imposed by the ALARA criteria and the exposure limits are discussed. The possibility of even lower limits is brought up. Exposure experience is presently running at ca. 500 man-rem/unit/year. Examples of radiation levels at various locations in the plants, and typical radioactive maintenance problems are presented. Means to control the formation and deposition of activated corrosion products are discussed.

DOSIMETRY

REFER ALSO TO CITATION(S) 1903

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 1000, 1129, 1825

1907 (IS-M—135) Role of quantum fluctuations in a spin glass. Klemm, R.A. (Ames Lab., IA (USA)). 1978. Contract W-7405-ENG-82. 5p. (CONF-780824—6). Dep. NTIS, PC A02/MF A01.

From 15. conference on low temperature physics; Grenoble, France (23 Aug 1978).

The mean-field theory of a quantum Heisenberg spin glass is performed using the variational approach and the replica method. For spin $1/2$, there is no spin glass phase. For 1 equal to or less than s less than infinity, a spin glass phase may exist for T_1 less than T equal to or less than T/sub f/, where T/sub f/ is the freezing temperature, and at T_1 the system exhibits a first-order transition back to the paramagnetic state.

1908 (LA-UR—78-1603) Crack identification and characterization in long wavelength elastic wave scattering. Gubernatis, J.E.; Domany, E. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 24p. (CONF-780650—7). Dep. NTIS, PC A02/MF A01.

From 1. symposium on ultrasonic materials characterization; Gaithersburg, MD, USA (7 Jun 1978).

We discuss apparent characteristic features of Rayleigh scattering of elastic waves from cracks. Interpreting these features, a procedure is suggested that in some experimental situations may be useful to distinguish generally-shaped cracks from volume defects and to determine from elliptically-shaped cracks the orientation, shape and size.

1909 Diffusion tensor for atomic migration in crystals. Larsen, E.W.; Schuss, Z. (Theoretical Division, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, 87545). *Phys. Rev., B:* **18**: No. 5, 2050-2058(1 Sep 1978).

The diffusion of holes or interstitials in a crystal is treated by several types of asymptotic analyses, of which the starting point is the Fokker-Planck equation. First, we show that the standard Smoluchowski equation holds, for large as well as intermediate or small values of the interatomic potential Phi, as an approximation of the Fokker-Planck equation. Next, we derive from the Smoluchowski equation a "homogenized" Smoluchowski equation, which contains only constant coefficients. Finally, we expand these coefficients for large Phi and obtain explicit formulas for the diffusion coefficients in terms of Phi and other physical quantities.

1910 Diffraction by small crystals on a single crystal substrate. Cowley, J.M.; Yu-Jeng, C. (Arizona State Univ., Tempe). *Surf. Sci.:* **72**: 379-389(1978).

Diffraction pattern intensities are calculated for a simple model of an overgrowth of small crystals on the surface of a single-crystal substrate when the lattice constants of the overgrowth and substrate differ but the centers of the overgrowth crystals lie at particular positions with respect to the substrate lattice. Estimates are made of the effects of the multiple scattering processes which are likely to occur in transmission and reflection electron diffraction. It is suggested that application of the usual methods of interpretation of these diffraction patterns would lead to false conclusions suggesting that pseudomorphic growth had occurred to modify the lattice constant of the overgrowth crystals to fit that of the substrate.

1911 Use of the Hart—Mortlock equation to interpret tracer diffusion results. Lundy, T.S. (Oak Ridge National Lab., TN). *Scr. Metall.;* **12**: No. 1, 95-98(1978).

There appears to be sufficient evidence for downgrading the use of the Hart-Mortlock equation to that of a rule-of-thumb for analysis of diffusion profiles that deviate only slightly from those known to be due to lattice diffusion. Apparently, it was used previously outside its appropriate range of validity and this led to erroneous rejection of short-circuit influences for diffusion results in certain systems. Hart-Mortlock could be more useful if such influences as penetration depth and surface diffusion were appropriately considered. (GHT)

1912 Possible light scattering experiment to detect the three-dimensional Wigner lattice. Dalven, R. (Univ. of California, Berkeley). *Philos. Mag.;* **35**: No. 3, 801-803(1977).

It is proposed that a possible experiment to detect the three-dimensional Wigner electron lattice is the study of Brillouin scattering of photons by the LA and TA modes of vibration of the lattice.

1913 Phenomenological and microscopic models of sublattice disorder in ionic crystals. I. Phenomenological models. Welch, D.O.; Dienes, G.J. (Brookhaven National Lab., Upton, NY). *J. Phys. Chem. Solids;* **38**: 311-317(1977).

The nature of phase transitions which arise from two classes of phenomenological models for the free energy of ionic crystals containing Frenkel disorder of one constituent is examined. In one class of models, defect-produced energy and excess entropy vary quadratically with defect concentration, while in the second class the energy per added defect is damped by disorder more rapidly than in the first class. The order of phase transitions and their effect on the effective carrier concentration for electrical conductivity are discussed.

1914 Can the sign of the EFG be obtained from combining TDPAC and Moessbauer techniques. Hoy, G.R. (CEN, Grenoble, France); Chappert, J.; Benski, H.C. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 72-75(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

A proposed new technique for measuring the sign of the electric field gradient (EFG) is studied by combining the methods of time differential perturbed angular correlation (TDPAC) and Moessbauer spectroscopy. The experiments do not confirm such a suggestion, and recent calculations show that the effect does not exist.

1915 Dispersion amplitudes in the Moessbauer lineshape of ^{237}Np, ^{182}W, and ^{195}Pt. Potzel, W. (Technische Universitaet Muenchen, Garching, Ger.); Wagner, F.E.; Kalvius, G.M.; Asch, L.; Spirlet, J.C.; Mueller, W. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 38, 77-86(1977). (CONF-770688—).

From 38. AIP conference on new directions in Moessbauer spectroscopy; Argonne, IL, USA (10 Jun 1977).

Measurements of the dispersion amplitude for the Moessbauer resonances in ^{237}Np (60 keV), ^{182}W (100 keV) and ^{195}Pt (99 keV) are reported. For the E1 transition in ^{237}Np a value of $xi = -(3.4 + 0.2) \times 10^{-2}$ was found. Theoretical estimates of xi for this case are of limited accuracy and the comparison with experimental data is inaccurate because of the considerable line broadening. Computer simulations show the influence of xi on ^{237}Np hyperfine spectra. For the E2 transition in ^{182}W the dependence of the effective value of xi on absorber thickness was studied. Extrapolations to zero thickness yield $xi = -(1.0 +- 0.1) \times 10^{-2}$ in good agreement with theoretical calculations. For ^{195}Pt we found $xi = -(1.1 +- 0.3) \times 10^{-2}$ for the dispersion amplitude at zero absorber thickness. This is the first pure M1 transition for which a dispersion term has been observed. For all three resonances the dispersion is large enough to affect the determination of isomer shifts.

SOLID STATE PLASMA

1916 (LA-UR—78-1871) Intervalence band absorption in electron hole droplets. Silver, R.N.; Aldrich, C.H. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 6p. (CONF-780919—1). Dep. NTIS, PC A02/MF A01.

From 14. conference on the physics of semiconductors; Edinburgh, UK (4 Sep 1978).

The broad absorption lineshape observed for transitions between the heavy hole and spin orbit split bands in EHD in Ge is explained. It is due to the momentum spreading of the hole wave function as calculated by multiple scattering theory.

SUPERCONDUCTIVITY

GENERAL THEORY

1917 Frequency singularities of the dissipation in the mixed state of pure type-II superconductors at low temperatures. Kopnin, N.B. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 7, 390-393(5 Apr 1978).

The dissipative part of the conductivity tensor in extremely pure superconductors at low temperatures has a peak at a frequency $\omega \sim \Delta^2$/E/sub F/, due to the presence of bound states in the vortex cores.

1918 Superconductivity of layer crystals. Lukiyanets, B.A.; Tovstyuk, K.D. (Institute of Semiconductors, Academy of Sciences of the Ukrainian SSR, Kiev). *Sov. Phys. - Solid State (Engl. Transl.);* **20**: No. 4, 733-734(Apr 1978).

The BCS model is used to calculate the properties of the energy gap in "true" layer structures.(AIP)

1919 Peak effect in the dependence of the critical current of a superconductor on the magnetic field. Larkin, A.I.; Ovchinnikov, Y.N. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 280-284(5 Mar 1978).

Near the critical field in a type-II superconductor, the magnetic force lines become detached from flexural deformations of the Abrikosov lattice. This effect leads to additional softening of the lattice and to a sharp increase of the critical pinning current.

1920 Triplet pairing in superconductors with a strong Kohn anomaly. Efetov, K.B. (L. D. Landau Institute of Theoretical Physics, USSR Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 1020-1025(Nov 1977).

The strong Kohn anomaly, which sets in when a metal is close to a structural transition, can lead to superconducting pairing with unity spin. Proximity to the structural transition leads also to polarization of the lattice by impurities. As a result, the impurities grow to "giant" dimensions and begin to scatter electrons much more strongly, thereby decreasing the mean free path. It is shown that such "giant" impurities do not destroy the produced superconducting state even if the mean free path is much shorter than the size of the Cooper pair.

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 1036, 1037, 1041, 1067

1921 (IS-M—132) **Flux-flow voltage pulses in superconductors.** Clem, J.R. (Ames Lab., IA (USA)). 1978. Contract W-7405-ENG-82. 8p. (CONF-780824—11). Dep. NTIS, PC A02/MF A01.

From 15. conference on low temperature physics; Grenoble, France (23 Aug 1978).

A new theoretical method for the calculation of the measured voltage pulse produced by a moving flux vortex or flux tube is described.

1922 Concerning the stability of the critical state in type-II superconductors. Mintz, R.G. (Institute of High Temperatures, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 8, 417-420(20 Apr 1978).

Electromagnetic-field and temperature oscillations preceding the jump of the magnetic flux in type-II superconductors are considered.

1923 Giant oscillations of thermal conductivity of the intermediate state of a superconductor. Bezuglyi, E.V. (Physicotechnical Institute of Low Temperatures, Ukrainian Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 3, 140-143(5 Feb 1978).

A theoretical investigation was made of the oscillatory thermomagnetic effects in the intermediate state of superconductors with open Fermi surfaces. Giant oscillations of the coefficient of thermal conductivity, due to the open electron trajectories, were observed.

1924 Electronic thermal conductivity of clean superconductors. Geilikman, B.T.; Dushenat, M.I.; Chechetkin, V.R. (Moscow Physicotechnical Institute). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1213-1215(Dec 1977).

The temperature dependence of the electron-phonon thermal conductivity is obtained by numerical solution of the kinetic equation and compared with experiment.

THEORETICAL PHYSICS

GENERAL AND MISCELLANEOUS

1925 (DOE/ER—0010) **Report of the Subpanel on High Energy Physics Manpower of the High Energy Physics Advisory Panel.** (Department of Energy, Washington, DC (USA). Div. of High Energy Physics). Jun 1978. 59p. Dep. NTIS, PC A04/MF A01.

A report of a study by a Subpanel which was appointed by the High Energy Physics Advisory Panel (HEPAP) to examine the production in recent years of new researchers in high energy physics and the rate at which they have moved into short term and permanent positions in the field. The Subpanel made use of the 1973 and 1975 ERDA Census data, statistics collected by others, as well as a number of surveys conducted by the Subpanel itself. Even though many uncertainties and gaps exist in the available data, several important points are presented. (1) New Ph.D. production in high energy physics has decreased in recent years even more rapidly than in physics as a whole. (2) New Ph.D.'s in experimental and theoretical high energy physics have been produced for many years in roughly equal numbers in spite of the fact that employment in the field at all levels shows a ratio of experiment-to-theory approaching two-to-one. (3) A very large fraction of the approximately 1700 Ph.D.'s in high energy physics (employed at 78 universities and 5 national laboratories) hold tenured positions (383 theorists and 640 experimentalists). (4) The age distribution of those in the tenured ranks reveals that the number of retirements will be extremely small during the next decade but will then start to have a significant impact on the opportunities for those who are seeking careers in the field. (5) Promotions to tenure at the universities during the 4 year interval AY72/73-AY76/77 have averaged about 10 per year in experiment and 10 per year in theory.

CLASSICAL AND QUANTUM MECHANICS

1926 Relation between the solutions of Newton's and Heisenberg's equations of motion. Halpern, F.R. (Department of Physics, B-019, University of California, San Diego, La Jolla, California 92037). *Phys. Rev., D;* **18**: No. 6, 1894-1900(15 Sep 1978).

For a class of problems it is shown that a solution to Newton's equation of motion may be interpreted as the generating function for the matrix elements of the coordinate operators in the Heisenberg representation. For three one-dimensional problems, the harmonic oscillator, the particle in a box, and the x^4 anharmonic oscillator, solutions to the quantum-mechanical problem are given in terms of the classical solution. A brief examination is made of a two-dimensional problem in which the angular momentum is conserved.

STATISTICAL PHYSICS AND THERMODYNAMICS

1927 (SAND—78-1227) **Computational stability of the Von Neumann—Richtmyer method for the case of the ideal gas law.** Hicks, D.L. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 42p. Dep. NTIS, PC A03/MF A01.

Two stability concepts are of interest for partial difference equations—one arises in theory—the other in practice. The theoretical kind, referred to here as asymptotic stability, is essentially just asymptotic (as $\Delta t, \Delta x \to 0$) boundedness of the discrete solution. The other kind, referred to here as computational stability, is stability for a fixed Δt and Δx—computational instability is indicated in practice by oscillatory behavior of the discrete approximation—in particular, oscillations of period $2\Delta x$. This report is concerned with computational stability. Only approximate stability analyses of the von Neumann-Richtmyer scheme have been done for the case of the ideal gas law. Herein a more rigorous computational stability analysis is sought. The analysis leads to a recommendation for the improvement of the time step restriction in WONDY for the case of the ideal gas law.

1928 Nonequilibrium distributions on a lattice from an operator formalism. Knodel, D.A.; Hoffman, D.K. (Ames Laboratory, USDOE, and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* **69**: No. 7, 3438-3439(1 Oct 1978).

The distribution function for n events at specified set of lattice points is derived in an operator formalism.(AIP)

ELECTRICITY AND MAGNETISM

1929 Computer codes for EMP interaction and coupling. Bevensee, R.M.; Brittingham, J.N.; Deadrick, F.J.; Lehman, T.H.; Miller, E.K.; Poggio, A.J. (Univ. of California, Livermore). *IEEE Trans. Antennas Propag.;* **AP-26**: No. 1, 156-165(Jan 1978).

The properties of a number of digital computer codes appropriate for various classes of external coupling problems are described. Limitations and approximations of numerical methods in

general are reviewed. Thin-wire codes are tabulated to indicate their basic properties, special features, and structures analyzed, including grid models of surfaces and wire stick models of aircraft. Surface codes are tabulated for bodies of revolution, arbitrary surfaces, and hybrid surface-wire or surface-aperture configurations in or below the "resonance" regime; and GTD codes, for higher frequencies. Various aperture codes for studying apertures in planes, in empty bodies, or with a wire pickup behind the aperture are summarized and tabulated. Some codes for long cables above or below the earth are reviewed. Conclusions warn against imprudent use of computer codes in general. 4 tables, 51 references.

MATHEMATICAL PHYSICS

1930 Illustration of the Lie group framework for soliton equations: Generalizations of the Lund—Regge model. Corones, J. (Department of Mathematics and Ames Laboratory: USDOE, Iowa State University, Ames, Iowa 50011). *J. Math. Phys. (N.Y.);* **19**: No. 12, 2431-2436(Dec 1978).

The Lie group framework for soliton equations is illustrated. It is shown that the original Lund—Regge model is one of an infinite family of similar relativistically invariant models that possess associated eigenvalue problems and isospectral flows. The models are explicitly found and their associated structures displayed. The group theoretic significance of the soliton equations and associated structures are given in accordance with the general theory.

1931 Numerical solutions of exterior problems with the reduced wave equation. Kriegsmann, G.; Morawetz, C.S. (University of Nebraska, Lincoln, Nebraska 68508). *J. Comput. Phys.;* **27**: No. 4, 181-197(Aug 1978).

A new technique for numerically solving the reduced wave equation on exterior domains is presented. The method is basically a relaxation scheme. It is general enough to handle both inhomogeneous and nonlinear indices of refraction. Although the convergence is slow, the technique is tested on two classical problems: the scattering of a plane wave off a metal cylinder and off a metal sphere. The results are in good qualitative agreement with previously calculated values. In particular, the numerical solutions exhibit the correct diffractive effects at moderate frequencies.

COMMUNICATION, EDUCATION, HISTORY, AND PHILOSOPHY

REFER ALSO TO CITATION(S) 1925

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 2002

1932 (COO—3170-7) **Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.** (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies). [nd]. Contract EY-76-S-02-3170. 375p. Dep. NTIS, PC A16/MF A01.

Separate abstracts were prepared for each of the 12 included papers. (MOW)

1933 (COO—3170-7, pp 7p, Paper 6) **Wave reflection from the lower hybrid surface: a toroidal effect.** Ott, E.; Wersinger, J.M. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

In toroidal geometry, the equilibrium magnetic field does not lie in the lower hybrid surface, $\omega = \omega/\text{sub LH}/(r)$. As a consequence, waves can be reflected from the lower hybrid surface rather than encountering a resonance (or mode conversion to a hot plasma wave). The implications of this for energy transport and deposition in tokamaks are investigated with a toroidal geometry, lower hybrid ray trajectory code.

1934 (COO—3170-7, pp 53p, Paper 9) **Theory of plasma heating by magnetosonic cavity mode absorption.** Ott, E.; Wersinger, J.M.; Bonoli, P.T. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

Absorption of magnetosonic cavity modes by excitation of the spatial Alfven resonance and by resonant particle absorption (transit time magnetic pumping) are studied and the strengths of the two damping mechanisms compared. For the mode studied, the poloidal mode number is low. This implies that the magnetosonic turning point is close to the Alfven resonance. To deal with the resulting differential equation an asymptotic expansion technique is utilized, first using ideal magnetohydrodynamic equations, and, subsequently, with finite ion Larmor radius effects included. The antenna impedance and cavity Q are studied as a function of plasma and antenna parameters. It is found that either Alfven resonance or resonant particle absorption dominate depending principally on radial mode number.

1935 (LA-UR—78-717) **Recent developments in linear theta-pinch research: experiment and theory.** McKenna, K.F.; Bartsch, R.R.; Commisso, R.J. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 4p. (CONF-780811—8). Dep. NTIS, PC A02/MF A01.

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

High energy plasmas offusion interest can be generated in linear theta pinches. However, end losses present a fundamental limitation on the plasma containment time. This paper discusses recent progress in end-loss and end-stoppering experiments and in the theoretical understanding of linear theta-pinch physics.

1936 (LA-UR—78-1914) **Field reversal experiments (FRX).** Linford, R.K.; Armstrong, W.T.; Platts, D.A.; Sherwood, E.G. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 16p. (CONF-780811—13). Dep. NTIS, PC A02/MF A01.

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

The equilibrium, confinement, and stability properties of the reversed-field configuration (RFC) are being studied in two theta-pinch facilities. The RFC is an elongated toroidal plasma confined in a purely poloidal field geometry. The open field lines of the linear theta pinch support the closed-field RFC much like the vertical field centers the toroidal plasma in a tokamak. Depending on stability and confinement properties, the RFC might be used to greatly reduce the axial losses in linear fusion devices such as mirrors, theta pinches, and liners. The FRX systems produce RFC's with a major radius R = 2-6 cm, minor radius a approximately 2 cm, and a total length l approximately 35 cm. The observed temperatures are T/sub e/ approximately 100 eV and T/sub i/ = 150-350 eV with a peak density n approximately 2×10^{15} cm^{-3}. After the plasma reaches equilibrium, the RFC remains stable for up to 30 μs followed by the rapid growth of the rotational m = 2 instability, which terminates the confinement. During the stable equilibrium, the particle and energy confinement times are more than 10 times longer than in an open-field system. The behavior of the m = 2 mode qualitatively agrees with the theoretically predicted instability for rotational velocities exceeding some critical value.

1937 (LBL—7298) **Design data for calculating neutral beam penetration into Z/sub eff/ > 1 plasmas.** Olson, R.E.; Berkner, K.H.; Graham, W.G.; Pyle, R.V.; Schlachter, A.S.; Stearns, J.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1978. Contract W-7405-ENG-48. 3p. (CONF-780811—10). Dep. NTIS, PC A02/MF A01.

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Impurities such as C, N, O, Fe, and Mo in a confined plasma reduce the penetration of the energetic neutral deuterium or hydrogen beam injected for heating or fueling the plasma, thus affecting the energy- and fuel-deposition profiles. New calculations, confirmed by recent experimental results, show that previous estimates of the reduction of neutral beam penetration due to impurities in the plasma were overly pessimistic. Until recently, the cross sections used to calculate beam attenuation had been assumed to be q^2times the cross section for $H^+ + H$ obtained from the Born approximation, where q is the charge state of the ion. This led to very large cross sections for large values of q, and thus to very stringent requirements on the acceptable level of impurity ions in the plasma.

1938 Axial translation of field-reversing E layers. Rej, D.J.; Tuszewski, M.; Davis, H.A.; Fleischmann, H.H. (School of Applied and Engineering Physics, Cornell University, Ithaca, New York 14853). *Appl. Phys. Lett.;* **33**: No. 11, 910-912(1 Dec 1978).

Experiments are described in which field-reversing E layers were transported axially in RECE-Christa over a distance of up to 10 ring radii using time-varying magnetic fields. When properly executed, this process does not lead to anomalous fast-electron losses. The translation speed appears consistent with that expected from the interaction of the rings with the axial B/sub z/-field gradients and the resistive tank wall. No significant difference is observed between moving the rings in a homogeneous H_2 fill and

moving them from a transient gas cloud into a low-gas-density region.

1939 Time evolution of mass flows in a collisional tokamak. Hassam, A.B.; Kulsrud, R.M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 12, 2271-2279(Dec 1978).

The time evolution, due to dissipative processes, of an initial pattern of poloidal and toroidal mass flows in a tokamak is considered. The calculation is applicable to a collisional, low β, axisymmetric tokamak of arbitrary minor cross section. Time rates of change of poloidal flows which are subsonic but larger than the diamagnetic speed are given according to the magnitude of the flow and the collisionality of the plasma. Over most of parameter space for typical tokamaks, the poloidal rotation is strongly damped by magnetic pumping at the rate $(l/qR)^2\nu/\text{sub i}/i$, where l is the mean free path, qR is the "connection length," and $\nu/\text{sub i}/i$ is the ion-ion collision frequency. At higher speeds, even stronger damping is effected by electron thermal conduction. The toroidal rotation is determined largely by the conservation of toroidal angular momentum. A heuristic explanation of the damping due to magnetic pumping is given.

1940 Analytic, high β, flux conserving equilibria for cylindrical tokamaks. Sigmar, D.J.; Vahala, G. (Fusion Energy Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Fluids;* **21**: No. 12, 2280-2286(Dec 1978).

Using Grad's theory of generalized differential equations, the temporal evolution from low to high β due to "adiabatic" and nonadiabatic (i.e., neutral beam injection) heating of a cylindrical tokamak plasma with circular cross section and peaked current profiles is calculated analytically. The influence of shaping the initial safety factor profile and the beam deposition profile and the effect of minor radius compression on the equilibrium is analyzed.

1941 l=1,2 high-beta stellarator. Bartsch, R.R.; Cantrell, E.L.; Gribble, R.F.; Klare, K.A.; Kutac, K.J.; Miller, G.; Siemon, R.E. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **21**: No. 12, 2287-2294(Dec 1978).

The final scyllac experiments are described. These experiments utilized a feedback-stabilized, l=1,2 high-beta stellarator configuration and like the previous feedback-stabilization experiments were carried out in a toroidal sector, rather than a complete torus. The energy confinement time, obtained from excluded flux measurements, agrees with a two-dimensional calculation of particle end loss from a straight theta pinch. Because simple end loss was dominant, the energy confinement time was independent of whether equilibrium adjustment or feedback stabilization fields were applied. The dynamical characteristics of the toroidal equilibrium were improved by elimination of the l=0 field used previously, as expected from theory. A modal rather than local feedback control algorithm was used. Although feedback clearly decreased the m=1 motion of the plasma, the experimental test of modal feedback, which is expected from theory to be superior to local feedback, is considered inconclusive because of the limitations imposed by the sector configuration.

1942 Experimental demonstration of E x B plasma divertor. Strait, E.J.; Kerst, D.W.; Sprott, J.C. (Department of Physics, University of Wisconsin-Madison, Madison, Wisconsin 53706). *Phys. Fluids;* **21**: No. 12, 2342-2345(Dec 1978).

The E x B drift due to an applied radial electric field in a tokamak with poloidal divertor can speed the flow of plasma out of the scrape-off region, and provide a means of externally controlling the flow rate and thus the width of the density fall-off. An experiment in the Wisconsin levitated toroidal octupole, using E x B drifts alone, demonstrates divertor-like behavior, including 70% reduction of plasma density near the wall and 40% reduction of plasma flux to the wall, with no adverse effects on confinement of the main plasma.

1943 Magnetic fields due to laser-light absorption. Woo, W.; DeGroot, J.S. (Department of Applied Science, University of California, Davis, California 95616). *Phys. Fluids;* **21**: No. 11, 2072-2075(Nov 1978).

A derivation is presented of a new expression for the slowly varying (dc) magnetic field generated by the absorption of laser light. Good agreement is found between results calculated from the new expression and results from simulation calculations and experiments. When applied to the resonant absorption of high powered laser light, it is shown that mega-Gauss dc magnetic fields can extend well into the overdense region for high enough resistivity. Therefore, they can inhibit the laser heated electron thermal conductivity.

1944 Equilibria of high pressure elliptic flux-conserving tokamak. Mizoguchi, T.; Kammash, T.; Sigmar, D.J. (University of Michigan, Ann Arbor, Michigan 48109). *Phys. Fluids;* **21**: No. 11, 2086-2089(Nov 1978).

An analytical calculation is carried out to determine the plasma current and poloidal beta for a toroidal plasma with an elliptic cross section under the constraint of flux conservation. It is shown that the pressure buildup during heating occurs in two stages: An outward shift in the magnetic axis and an elongation in the flux surfaces. The total plasma current increases with the pressure variable more rapidly for an elliptic cross section than it does for a circular cross section. This current rise produces a rather slow rise of the poloidal beta with pressure, particularly for large elongations. The ensuing class of flux conserving equilibria is characterized by large beta but modest poloidal beta.

1945 Computer modeling of linear theta pinch machines. Stover, E.K.; Klevans, E.H.; York, T.M. (The Pennsylvania State University, University Park, Pennsylvania 16802). *Phys. Fluids;* **21**: No. 11, 2090-2102(Nov 1978).

A zero-dimensional time dependent computer model is developed to describe post implosion behavior of a radially diffuse plasma column in linear theta pinch machines. The model consists of five first-order differential equations for electron temperature T/sub e/, ion temperature T/sub i/, plasma column area A/sub p/, magnetic field embedded in the plasma column B/sub i/, and number of electrons in the plasma column N, and incorporates the effects of particle end loss, electron and ion thermal conduction, magnetic compression of the plasma, electron-ion energy transfer, Ohmic heating of the electrons, and magnetic field diffusion. End-on interferometric experimental data, which indicate that particle confinement time scales as $L[m/\text{sub i}/(T/\text{sub e}/+T/\text{sub i}/)]/\text{sup } 1/2/$, where m/sub i/ is the ion mass and L is the compression coil length, are used as a guide to the choice of an end loss parameter. Numerical predictions of on-axis density and plasma temperature are found to be in reasonably good agreement with experimental results from both the collisional Scylla I-C experiment and the hot collisionless Scylla IV-P experiment. These comparisons are used to identify important physical mechanisms characterizing the behavior of a particular machine including: the significance of thermal conduction on both plasma temperature and particle end loss; the importance of magnetic field diffusion; and the impact of using a time independent end loss scaling parameter.

1946 Effects of an axial heat flux limit in linear thcta pinches. Gary, S.P.; Sgro, A.G.; DeSilva, A.W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **21**: No. 11, 2103-2107(Nov 1978).

With a simple model for classical electron thermal conduction and an arbitrary axial density profile, the axial electron temperature profile T (z) and cooling time t/sub c/ in a linear theta pinch may be computed. Densities that decrease with increasing axial position provide the more favorable conditions for the failure of classical heat conduction. Introduction of a heat flux limit in such a profile increases t/sub c/ and reduces the gradient of T (z) over most of the plasma.

1947 Density dependence of electron cyclotron heating rate in a toroidal octupole. Wong, K.L. (University of Wisconsin, Madison, Wisconsin 53706). *Phys. Fluids;* **21**: No. 11, 2108-2111(Nov 1978).

Electron cyclotron heating rates have been measured for low density plasmas ($\omega/\text{sub p}/\text{every-much-less-than}\omega$) in a toroidal octupole by the sweep method with resonance zones situated near the minor axis of the torus. The energy absorbed by the plasma from the 100 mW frequency sweep oscillator is determined from the broadening of the cavity modes. The scaling of heating rate with plasma density differs from previous results of high frequency (9.6 GHz) cavity mode measurements. The difference is explained by the accessibility of the waves to the resonance zones.

1948 Runaway of the front of a shock wave near a metallic surface, and mechanism of the destruction on the current sheath in a noncylindrical Z-pinch Velikovich, A.L.; Liberman, M.A. (Institute of Physics Problems, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 8, 420-422(20 Apr 1978).

It is shown that heating the surface of an anode and of a gas layer adjacent to it by radiation of a current sheath is the cause of the runaway of part of the current-sheath front adjacent to the anode. The evolution of this process is also the cause of the destruction of the current sheath of the plasma focus.

1949 Ion beam excitation of ion-cyclotron waves and ion heating in plasmas with drifting ions. Hauck, J.P.; Boehmer, H.; Rynn, N.; Benford, G. (California Univ., Irvine (USA). Dept. of Physics). *J. Plasma Phys.;* **19**: 237-252(Apr 1978).

Ion-cyclotron waves are excited by cesium and potassium ion beams in cesium and potassium Q-machine plasmas. The ion beams are injected along the magnetic field with care to avoid beam transverse velocities. The observed ion-cyclotron mode frequencies are below those driven by electron currents. These resonant instabilities are convective in character with small spatial growth rates ksub(i)/ksub(r) approximately equal to 0.05. Plasma ion heating is

observed and is consistent with a model in which mode amplitudes are saturated by diffusion effects.

1950 Ion beam excitation of ion-cyclotron waves and ion heating in plasmas with drifting electrons. Hauck, J.P.; Boehmer, H.; Rynn, N.; Benford, G. (California Univ., Irvine (USA). Dept. of Physics). *J. Plasma Phys.;* **19**: 253-265(Apr 1978).

Ion-cyclotron waves are excited by a cesium ion beam in a cesium Q-machine plasma with drifting plasma electrons. These interactions differ significantly from those in the case of drifting ions in that the drifting electrons play an active role in the instability mechanism. The observed mode frequencies are slightly below those of the electron current driven modes. These waves can be convectively or absolutely unstable, depending on the ion beam velocity. For low beam velocities the instabilities are convective in character with large spatial growth rates ksub(i)/k'sub(r) approximately equal to 0.2. For larger beam velocities the instabilities are absolute in character with temporal growth rates γ/ωsub(ci) approximately equal to 0.04. The absolute instabilities are similar to two-stream instabilities. Plasma ion heating is observed and is consistent with a model in which mode amplitudes are saturated by diffusion effects.

1951 Contribution to the theory of thermal modulation instability. Burinskaya, T.M.; Volokitin, A.S. (Institute of Space Research, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 6, 301-304(20 Mar 1978).

We investigate the nonlinear stage of the development of wave modulation instability produced in a magnetized plasma when the latter is heated. The analysis is confined to a one-dimensional model with modulation of the density transverse to the magnetic field. Numerical solutions and theoretical estimates are obtained for the parameters of the resultant structure.

1952 Neutron emission in big tokamaks. Zaveryaev, B.S.; Luk'yanov, S.Y. *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 937-942(Nov 1977).

Possible mechanisms of neutron emission in large tokamaks are discussed. It is shown that the observed neutron yields agree well with the calculated value under normal operating conditions of the T-10 installation. The anomalous neutron emission, which reaches 10^{12}—10^{13} neutrons per discharge, is attributed to a photonuclear reaction on the diaphragm. Estimates of the current of the relativistic electron beam under conditions are presented. The anomalous behavior of the neutron intensity in individual discharges is attributed to electrodisintegration of the plasma deuterium.

1953 Plasma-wave interaction at the frequency above the low hybrid one. Anisimov, A.I.; Baranov, Yu.F.; Bulyginskii, D.G.; Vinogradov, N.I.; Golant, V.E.; Shustova, N.V. (AN SSSR, Leningrad. Fiziko-Tekhnicheskij Inst.); Dyatlov, Yu.P. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). *Zh. Tekh. Fiz.;* **47**: No. 4, 761-765(Apr 1977). (In Russian).

The regularities of absorption of electromagnetic waves have been experimentally investigated at the frequencies exceeding the lower hybrid one in a plasma with toroidal geometry of a magnetic field. The experimental facility is a metal toroidal chamber with large and small diameters 43 and 10 cm respectively, placed in a quasi-stationary magnetic field of 3 kOe. The discharge in hydrogen at the pressure p=10^{-4}-10^{-3} mm Hg is sustained by introducing into the chamber SHF power of 100 W at wavelength of 3 cm satisfying the conditions of the cyclotron and the upper hybrid resonances. The plasma parameters are the following: nsub(e) approximately 10^{11} cm^{-3}, Tsub(e) approximately 5-10 eV. The HF power under investigation at f=440 MHz and Wsub(max)=2 kW is introduced by pulses of controlled duration by a dipole antenna. It has been revealed that under the hydrogen pressure of 10^{-3} mm Hg absorption takes place in the exterior part of the discharge, that is apparently connected with the collisional absorption of the surface mode. At lower pressures a decrease of the plasma density is observed under the effect of the HF power. The mechanisms which may provide explanation to the phenomena observed have been discussed.

PLASMA DIAGNOSTICS

REFER ALSO TO CITATION(S) 2024

1954 (LA-UR—78-2060) **Comparison of Fresnel zone plates and uniformly redundant arrays.** Fenimore, E.E.; Cannon, T.M.; Miller, E.L. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 6p. (CONF-780829—2). Dep. NTIS, PC A02/MF A01.

From 22. symposium and instrument display; San Diego, CA, USA (28 Aug 1978).

Several imaging systems in laser fusion, e-beam fusion, and astronomy employ a Fresnel zone plate (FZP) as a coded aperture. The recent development of uniformly redundant arrays (URAs) promises several improvements in these systems. The first advantage of the URA is the fact that its modulation transfer function (MTF) is the same as the MTF of a single pinhole, whereas the MTF of an FZP is an erratic function including some small values. This means that if inverse filtering is used, the URA will be less susceptible to noise. If a correlation analysis is used, the FZP will produce artifacts whereas the URA has no artifacts (assuming planar sources). Both the FZP and URA originated from functions which had flat MTFs. However, practical considerations in the implementation of the FZP detracted from its good characteristics whereas the URA was only mildly affected. The second advantage of the URA is that it better utilizes the available detector area. With the FZP, the aperture should be smaller than the detector in order to maintain the full angular resolution corresponding to the thinnest zone. The cyclic nature of the URA allows one to mosaic it in such a way that the entire detector area collects photons from all of the sources within the field of view while maintaining the full angular resolution. If the FZP is as large (or larger) than the detector, all parts of the source will not be resolved with the same resolution. The FZP does have some advantages, in particular its radial symmetry eases the alignment problem; it has a convenient optical decoding method; and higher diffraction order reconstruction might provide better spatial resolution.

1955 (ORNL—5405, pp 1-18) **High beta plasma.** Dandl, R.A.; Baity, F.W.; Becker, M.C. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

The main thrust of the experimental efforts in 1977 was directed toward the measurement of radial profiles of most key plasma parameters, mainly in the stable T-mode operation of EBT-I. Ion temperature and density profiles were measured by charge exchange neutral particle analysis, neutral hydrogen and impurity ion density profiles were measured spectroscopically, and plasma potential profiles were measured using the heavy ion beam probe technique for the first time. Work is continuing on the development of a new soft x-ray detector for measuring electron temperature profiles and a ruby laser scattering apparatus for measuring electron density profiles.

1956 (ORNL—5405, pp 69-73) **Diagnostic development.** Barnett, C.F.; Brisson, D.A.; Greco, S.E. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

During the past year the far-infrared or submillimeter diagnostic research program resulted in three major developments: (1) an optically pumped 0.385-μm D_2O-laser oscillator-amplifier system was operated at a power level of 1 MW with a line width of less than 50 MHz; (2) a conical Pyrex submillimeter laser beam dump with a retention efficiency greater than 10^4 was developed for the ion temperature Thompson scattering experiment; and (3) a new diagnostic technique was developed that makes use of the Faraday rotation of a modulated submillimeter laser beam to determine plasma current profile. Measurements of the asymmetric distortion of the H/sub α/ (6563 A) spectral line profile show that the effective toroidal drift velocity, dv/sub two vertical bars i/dT/sub i/, may be used as an indicator of plasma quality and as a complement to other ion temperature diagnostics.

1957 (PPPL—1447) **Techniques for the reconstruction of two-dimensional images from projections.** Sauthoff, N.R.; Von Goeler, S. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Aug 1978. Contract EY-76-C-02-3073. 30p. Dep. NTIS, PC A03/MF A01.

Several plasma diagnostics techniques measure the line integrals of quantities such as densities and optical, ultraviolet, and X-ray emission. Some approaches for reconstructing the local quantities from their line integrals, based on methods utilized in computerized tomography, electron microscopy, holographic interferometry, and radio astromony, are derived and presented. Results for the special cases with source functions posessing helical symmetry--ranging from DNA to MHD--are emphasized.

1958 (SAND—78-1252C) **Radiation from laser produced plasmas.** Gusinow, M.A.; Anthes, J.P.; Hays, G.N.; Patterson, E.L.; Matzen, M.K.; Palmer, M.A.; Glibert, K.M. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 9p. Dep. NTIS, PC A02/MF A01.

Two independent experiments are described which utilize an HF and an Nd:glass laser to produce a high density plasma from a solid target. The respective laser pulse widths were 70 and 8 ns (fwhm), and the energies nominally 5 to 30 joules and 5 to 60 joules. The plasma diagnostics were Faraday cups and Thomson parabola ion spectrometers. Radiation measurements utilized a multichannel K-edge spectrometer and XRDs. The results to be reported will include the laser energy absorbed, plasma color temperature, x-ray conversion efficiency (0.71 to 10 keV), and plasma ablation velocities.

1959 (SAND—78-1344C) **Soft x-ray, vacuum ultraviolet diagnostics of high density, high temperature plasmas.** Burns, E.J.T.

(Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 6p. (CONF-780679—2). Dep. NTIS, PC A02/MF A01.

From JOPWOG-6/SubWOG-268 meeting; Albuquerque, NM, USA (27 Jun 1978).

A grazing incidence spectrograph in conjunction with XRD's can be used for spectral and total flux measurements below 600 eV with an accuracy of about +-50%. A convex curved crystal spectrograph can be used in conjunction with PIN detectors above 600 eV for total flux and spectral measurements to an accuracy of about +-20%.

1960 (UCRL—13876) **Low-energy x-ray instrumentation for SHIVA. Final report.** (Lockheed Missiles and Space Co., Sunnyvale, CA (USA)). Jun 1978. Contract W-7405-ENG-48. 18p. (LMSC/D—628276). Dep. NTIS, PC A02/MF A01.

This document reports the results of a study by Lockheed Palo Alto Research Laboratory on the optimization of low-energy x-ray diagnostic instrument for the SHIVA laser facility at the Lawrence Livermore Laboratory. Preliminary outlines for the basic system and several components are presented, experimental considerations and techniques are recommended, and further studies are suggested.

1961 (UCRL—81156) **Diagnostics for the laser fusion program: plasma physics on the scale of microns and picoseconds.** Attwood, D.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 May 1978. Contract W-7405-ENG-48. 19p. (CONF-780318—1; CONF-780579—5). Dep. NTIS, PC A02/MF A01.

From 2. conference on high-temperature plasma diagnostics; Santa Fe, NM, USA (1 Mar 1978).

Laser induced fusion is the forerunner of a class of inertial confinement schemes in which hydrogen isotopes are heated to thermonuclear conditions in a very short period. The process is characterized by such short time scales that fuel confinement is achieved through its' own finite mass and expansion velocity, approaching 1 μm/psec for ignition temperatures of order 10 keV (10^8 °K). With current laser powers limited to several terrawatts one readily estimates, on the basis of energy conservation, target mass, and expansion velocity, that target size and laser pulse duration are on the order of 100 μm and 100 psec, respectively. Within these constraints, targets have been heated and confined to the point where thermonuclear conditions have been achieved. This paper describes a sampling of diagnostic techniques with requisite resolution (microns and picoseconds) to accurately describe the dynamics of a laser driven compression. As discussed in each case cited, these in turn provide insight to and quantitative measure of, the physical processes dominating the implosion. The success of the inertial confinement fusion program is strongly dependent on the continued development of such diagnostics and the understanding they provide.

1962 (UCRL—81240) **Diagnostics for mirror machines.** Osher, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Aug 1978. Contract W-7405-ENG-48. 39p. Dep. NTIS, PC A03/MF A01.

This paper is subdivided into three chapters to match three corresponding lectures. The goals of the first chapter are to define the neutral-beam-heated, quasi-d.c. mirror confinement systems under discussion here and to give a general example of mirror diagnostics by listing and very briefly discussing the diagnostics used on the 2XIIB experiment at the Lawrence Livermore Laboratory. The second chapter develops mirror machine diagnostics in more detail, and adds background for a few selected diagnostics of particular importance to mirror machine studies. The third chapter discusses the special diagnostic needs of future mirror machines, with emphasis on diagnostics involving the higher-power neutral beams used with them.

1963 **Radially resolved measurements of "q" on the adiabatic toroidal compressor tokamak.** Goldston, R.J. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 12, 2346-2353(Dec 1978).

A new technique for directly measuring the safety factor, or q, profile in a tokamak is described. A tightly collimated neutral beam capable of injecting approximately 100 mA of 30 keV deuterium atoms was mounted on the Adiabatic Toroidal Compressor tokamak. By proper tangential aiming of the beam a strong concentration of circulating fast ions was created at a chosen plasma minor radius. Through examination of the orbits of these ions with a multi-sight-line charge exchange detector, it was possible to measure the shifts of the orbits off magnetic surfaces, and thereby make local measurements of q. This experiement showed that when q on axis reached unity, strong internal turbulence began, and further lowering of q at the outer edge of the plasma did not lower q (0). A second result was that the measured q (0) was approximately 1.8 times larger than the q (0) deduced from the T/sub e/(r) profile, assuming Z/sub eff/ to be independent of minor radius. This suggests a significant peaking of Z/sub eff/ on axis.

1964 **Observation of a forbidden line Fe XX and its application for ion temperature measurements in the Princeton Large Torus tokamak.** Suckewer, S.; Hinnov, E. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **41**: No. 11, 756-759(11 Sep 1978).

A spectrum line in the Princeton Large Torus (PLT) tokamak discharges, with wavelength measured as 2665.1 +- 0.3 A, has been identified as the $2s^2p^3\ ^2D/sub\ 5/2/ \rightarrow\ ^2D/sub\ 3/2/$ magnetic dipole transition in Fe XX ground configuration. A variety of localized spectroscopic diagnostics, e.g., ion temperature and density distribution measurements in the high-temperature interior of the plasma, are feasible by means of forbidden lines of this type. The 2665-A line has been used to measure near-central ion temperature in a discharge with auxiliary neutral-beam heating.

1965 **Signal-to-noise scaling of ruby laser scattering from large-tokamak plasmas.** Lasalle, J.; Platz, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). *Plasma Phys.;* **20**: No. 2, 107-113(Feb 1978).

The signal-to-noise ratio (SNR) of Ruby laser scattering measurements is studied as a function of the minor radius a, the laser parameters and the characteristics of the detection system. On a tokamak of JET-like dimensions, the SNR will be reduced at least by a factor of 8 with respect to its value on TFR. Possible improvements of present-day scattering devices are discussed.

1966 **Experiments on plasma interactions with powerful r.f. discharges.** Lietti, A. (Ecole Polytechnique Federale, Lausanne (Switzerland)). *Plasma Phys.;* **20**: No. 1, 59-71(Jan 1978).

Linear discharges in a steady axial magnetic field are produced in hydrogen plasmas by means of unconventional line generators. Non-decaying current pulses range from 1 to 50 kA at a frequency of 3 MHz. The penetration of the azimuthal oscillating field is observed, and the influence of limiters is investigated. A critical current is found, and this result is compared with previous theory. Anomalous skin depth results from analysis of the complex wave vector, which shows energy exchanges with the plasma, in addition to the normal Joule heating. Decreasing conductivity at low densities indicates possible turbulent behaviour. An interesting feature of the discharges in the highest power range is the excitation of magnetosonic compressional waves at the second harmonic of the axial current with typical resonance effect. This quadratic interaction, not observed before, is explained with a simple model considering the pressure gradient at the plasma boundary.

1967 **Technique of optical polarization measurements of plasma Langmuir turbulence spectrum.** Zhuzhunashvili, A.I.; Oks, E.A. (I. V. Kurchatov Atomic Energy Institute). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 6, 1122-1129(Dec 1977).

We describe an optical method of measuring the amplitude-angle distribution of a high-frequency Langmuir turbulence; the method is based on a polarization analysis of the Stark profiles of hydrogen spectral lines. We determine with the aid of this method, for the first time ever, both the turbulence level and the directivity pattern of the Langmuir noise produced in a plasma upon annihilation of opposing magnetic fields.

PLASMA KINETICS - GENERAL

1968 (LAPS—43) **Interpretation of cyclotron radiation spectra from runaway discharges in TFR.** Tamor, S. (Science Applications, Inc., Los Angeles, CA (USA)). Aug 1978. Contract EY-76-C-03-1018. 21p. (SAI—78-804-LJ). Dep. NTIS, PC A02/MF A01.

The cyclotron radiation spectra from runaway tokamak discharges are discussed and numerical studies reported which attempt to fit the observed data with simple model electron distribution functions. The data imply that the underlying distribution function is one of two possible types. While one of these does not appear reasonable, the other is quite similar to that predicted by the theory for runaway dynamics of Parail and Pogutse. Satisfactory quantitative agreement between experiment and theory is found and some light shed upon the connection between initial breakdown conditions and the presence of runaways.

1969 **Thermal magnetic fluctuations and anomalous electron diffusion.** Lin, A.T.; Dawson, J.M.; Okuda, H. (Center for Plasma Physics and Fusion Engineering, University of California, Los Angeles, California 90024). *Phys. Rev. Lett.;* **41**: No. 11, 753-756(11 Sep 1978).

We investigate electron transport for a thermal plasma using a magnetostatic plasma model. Three cases are investigated; (1) fixed ions, only magnetic fluctuations; (2) fixed ions, magnetic and electrostatic fluctuations; (3) mobile ions, magnetic, and electrostatic fluctuations. For (1), magnetic islands as well as many unclosed field lines occurred; for (2) and (3) electrostatic convective cells occurred along with magnetic islands giving a much more turbulent situations. Generally the transport due to electrostatic convective cells dominated.

PLASMA KINETICS - EXPERIMENTAL

1970 (ORNL—5405, pp 19-57) **Experimental tokamak.** Berry, L.A.; Sheffield, J.; Dunlap, J.L. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

The papers which comprise the first part of this section analyze neutral beam-heated plasmas produced late in 1976 in ORMAK. The scaling of average electron temperature with total power input to electrons was found to be approximately the same with or without injection. Impurity radiation during concurrent neutral beam injection and gas puffing is shown to be strongly dependent on changes in the electron temperature profile. Tungsten radiation has been identified in the wavelength range of 40 to 60 A. Concentrations are estimated to be of the order of 10^{-3} n/sub e/. Further studies include internal MHD mode structure, distortion in the wings of the H/sub α/ line profile, wall power loss measurements, and neutron time behavior for deuterium neutral beam injection. The basic impurity study experiment, ISX, was completed and is described.

1971 (ORNL—5405, pp 121-128) **Atomic, molecular, and nuclear physics.** Barnett, C.F.; Crandall, D.H.; Gilbody, H.B. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

Measurements of electron capture cross sections were completed for multicharged ions of O, Si, Fe, Mo, Ta, W, and Au in H and H_2 in the energy range of 60 to 250 keV/amu (TFTR injection energy). Low energy (1.25 to 8.45 keV/amu) electron capture cross sections were measured for ions of the He and Li isoelectronic sequences in H and H_2. These measurements indicated that in this energy range there was no uniform scaling with ion charge and no general behavior of the cross section with velocity or energy. Hydrogen-like or completely stripped ions are difficult to obtain from conventional ion sources because of the large energy required to remove the electrons from the K-shell. To overcome this difficulty, we used a CO_2 laser beam to create a high temperature plasma from a C target. A power density of 4×10^9 W/cm^2 incident on a C solid target provided usable beams of C^{5+}. Equilibrium yields of D^- obtained by passing D ions and atoms through thick Cs vapor targets were reinvestigated in an attempt to remove discrepancies in the various measurements. Present D^- yields of 0.18 at a D energy of 300 eV are lower by approximately a factor of two than recent measurements of Schlachter et al.

1972 (ORNL/TM—6446) **Plasma-wall impurity experiments in ISX-A.** Colchin, R.J.; Bush, C.E.; Edmonds, P.H. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 21p. Dep. NTIS, PC A02/MF A01.

The ISX-A was a tokamak designed for studying plasma-wall interactions and plasma impurities. It fulfilled this role quite well, producing reliable and reproducible plasmas which had currents up to 175 kA and energy containment times up to 30 msec. With discharge precleaning, Z/sub eff/ was as low as 1.6; with titanium evaporation, Z/sub eff/ approached 1.0. Values of Z/sub eff/ greater than or equal to 2.0 were found to be proportional to residual impurity gases in the vacuum system immediately following a discharge. However, there was no clear dependence of Z/sub eff/ on base pressure. Stainless steel limiters were used in most of the ISX-A experiments. When carbon limiters were introduced into the vacuum system, Z/sub eff/ increased to 5.6. After twelve days of cleanup with tokamak discharges, during which time Z/sub eff/ steadily decreased, the carbon limiters tended to give slightly higher values of Z/sub eff/ than stainless steel limiters. Injection of less than 10^{16} atoms of tungsten into discharges caused the power incident on the wall to double and the electron temperature profile to become hollow.

1973 (UCID—17864) **Study of EUV emissions from 2XIIB.** Drake, R.P.; Chen, K.I.; Moos, H.W.; Terry, J.L.; Hornady, R.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Jun 1978. Contract W-7405-ENG-48. 48p. Dep. NTIS, PC A03/MF A01.

Initial results from a study of EUV emissions from the 2XIIB experiment are reported. Time-dependent brightness measurements of deuterium, oxygen, nitrogen, carbon and titanium emissions from the central 2XIIB plasma have been made. The deuterium Lyman alpha brightness is 1.5×10^{17} photons sec^{-1}cm^{-2}sr^{-1}. The Lyman alpha time development and broad spectral profile are consistent with other knowledge of the 2XIIB plasma. Oxygen is the dominant impurity in 2XIIB. The 0 VI 1032 A brightness is 1.65×10^{18} photons sec^{-1}cm^{-2}sr^{-1}. The oxygen concentration is 2% and its estimated confinement lifetime is 300 μs; this may imply mirror confinement of the oxygen ions. Nitrogen and carbon concentrations are 0.4% and 0.3%, respectively. It is not certain whether these impurities are mirror confined. The titanium concentration is believed to be low compared to that of oxygen. The power loss from the central plasma due to radiation by and ionization of light impurities is approximately 60 kW, which is 4% of the power deposited by the neutral beams. Further studies of impurity sources and penetration are now being performed.

1974 **Increase of the effectiveness of the interaction between a strong-current relativistic electron beam and a plasma.** Arzhannikov, A.V.; Burdakov, A.V.; Koidan, V.S.; Konyukhov, V.V.; Mekler, K.I.; Rogozin, A.I. (Nuclear Physics Institute, Siberian Division, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 3, 161-164(5 Feb 1978).

Experimental results are presented, which indicate that the effectiveness of interaction of a strong-current of a relativistic electron beam with a plasma is greatly increased when the beam angular divergence is decreased and when the external magnetic field is increased.

1975 **Trajectories of high energy electrons in a plasma focus.** Harries, W.L. (Old Dominion Univ., Norfolk, Va. (USA)); Lee, J.H.; McFarland, D.R. *Plasma Phys.;* **20**: No. 2, 95-106(Feb 1978).

The intensity of X-rays from a plasma focus is measured as a function of position, time, energy, and angle of emission. The low energy X-rays emanate from the plasma, but the high energy components come from a small region of the anode surface, on axis. Emission from the focus occurs some 20 ns prior to that from the anode, but the latter continues for 500 ns. X-ray 'shadow' techniques shows that the high energy electron travel in a beam almost perpendicular to the anode surface. Spatial plots of X-ray intensity at different energies show that the electrons gain energy as they approach the anode. No counter-streaming of high energy electrons away from the anode is evident. Polar diagrams of medium energy (approximately 20 keV) X-rays resemble a cardioid, but high energy (approximately 100 keV) X-rays are emitted in a narrow lobe toward the anode, with a forward-to-back ratio of about 50; both results are consistent with Bremsstrahlung emission from a beam of relativistic electrons. The relativistic beam current is estimated at several 100 A. The electric fields required to produce such electron trajectories are also consistent with the observed anisotropy of ion emission in a focus, and with the converging beam model of neutron production, proposed previously.

1976 **Ionization relaxation in shock-heated krypton-argon mixtures.** Ezumi, H. (Hiroshima Denki Inst. of Tech. (Japan)); Kawamura, M.; Yokota, T. *J. Phys. Soc. Jpn.;* **43**: No. 3, 1060-1067(Sep 1977).

The ionization relaxation processes behind shock waves in pure krypton and krypton-argon mixtures have been investigated using a Mach-Zehnder interferometer technique. The incident shock velocity was fixed in the neighborhood of Us=2800 m/sec, and the initial pressure was fixed at 0.95 Torr. The experimental results were compared with theoretical values based on the two-step collisional ionization model taking into account of the wall boundary-layer effect. The slope constants of excitation cross section against relative kinetic energy between krypton atom-atom collisions, krypton atom-electron collisions, and krypton-argon atom-atom collisions were determined to be 4.2×10^{-19} cm^2/eV, 1.2×10^{-17} cm^2/eV, and 4.2×10^{-19} cm^2/eV, respectively.

1977 **Measurements of HeI line profiles with forbidden components induced by fluctuating fields in a small theta pinch plasma.** Kawasaki, K. (Hiroshima Univ. (Japan). Faculty of Science). *J. Phys. Soc. Jpn.;* **43**: No. 2, 648-654(Aug 1977).

Spectral line profiles of HeI 4922 A line (2^1P-4^1D, ^{1}F) and 4471 A line (2^3P-4^3D,^{3}F) with their forbidden components from a small linear theta pinch plasma have been measured and the plasma satellites have been observed on the wing of the line profiles. The observed profiles have broadened wings, and they are interpreted as the Doppler broadening due to fast neutral particles produced by the charge transfer with hot ions in the plasma of the neutral particle density of $\sim 10^{14}$ cm^{-3} comparable with the plasma density. The low and high frequency fluctuating fields with the average strength of several kV/cm are deduced from the plasma satellites in the observed profiles.

PLASMA KINETICS - THEORETICAL

1978 (ANL/FPP/TM—113) **Disparate clump approximation in neoclassical plasma transport theory.** Boley, C.D.; Gelbard, E.M.; Hirshman, S.P. (Argonne National Lab., IL (USA)). Jul 1978. Contract W-31-109-ENG-38. 54p. Dep. NTIS, PC A04/MF A01.

A model of a multiple ion plasma is considered in which the system may contain many atomic species, each with an arbitrary number of charge states, but in which the atomic species are disparate in mass. Using this approximation is calculated in analytic form, the multispecies Spitzer function, from which there follow tractable expressions for the Ware fluxes and bootstrap current in a tokamak. In the collisional regime of a tokamak plasma, we obtain simple analytic results are obtained for the radial transport coefficients.

These results give rise to an efficient method of solving the ensuing diffusion equations.

1979 (CONF-780475—1) **Transport of ions with multiple charge states in neoclassical theory.** Boley, C.D.; Gelbard, E.M.; Hirshman, S.P. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From Controlled fusion theory conference; Gatlinburg, TN, USA (26 Apr 1978).

Solutions are given for the Fokker—Planck equations describing classical transport along a magnetic field. (MOW)

1980 (COO—3170-7, pp 67p, Paper 2) **Kinetic theory of ion ring compression.** Lovelace, R.V. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

A general kinetic theory is developed for the adiabatic compression of ion rings, and associated plasma, in an external magnetic mirror field B/sub e/(t). The single particle distribution function f(H,P/sub theta/,t) for a collisionless, axisymmetric ring is shown to evolve according to deltaf/.delta t + U delta f/delta H = 0 in the absence of instabilities and under conditions where the particle motion is ergodic in the poloidal (r,z) plane. Here, H and P/sub theta/ are the energy and canonical momentum of a ring ion, and U is a spatial average of the toroidal betatron electric field over the region of the r,z plane which is accessible to an ion with constants H and P/sub theta/ at time t. A complete description of ring compression is obtained from the equation for f, which gives the ring current-density J/sub b theta/, from an appropriate constitutive relation for the plasma response, which gives the plasma current-density J/sub p theta/, and from Ampere's law. The description is simplified by the existence of an adiabatic invariant I(H,P/sub theta/,t), which allows an explicit solution for f during compression as f = F(I,P/sub theta/), where F is an invariant function.

1981 (COO—3170-7, pp 29p, Paper 3) **New theory of astron equilibria.** Lovelace, R.V.; Larrabee, D.; Fleischmann, H.H. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

A new theory of astron ion-ring equilibria is developed. In contrast with previous equilibria, the new equilibria have a distribution of canonical momentum which is invariant to axisymmetric changes in the external magnetic field and in the boundary conditions at vessel walls. As a function of the single particle constants of the mation, the energy H and the canonical momentum P/sub theta/, the distribution function, f(H,P/sub theta/), is written as f = g(P/sub theta/) F(H,P/sub theta/) [A(H,P/sub theta)]$^{-1}$; where g(P/sub theta/) is the invariant distribution function for canonical momentum; where A(H,P/sub theta/) is the area of the poloidal (r,z) plane accessible to a ring particle with constants H and P/sub theta/, and where F(H,P/sub theta/) is a non negative function having the normalization integral aHF = const. With this representation of f, it becomes possible to study the adiabatic compression of ion-ring Vlasov equilibria.

1982 (COO—3170-7, pp 15p, Paper 10) **Method for improved convergence to high-beta equilibria in particle simulations.** Friedman, A.; Sudan, R.N. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

We present a method for the generation of quiet high-beta axisymmetric equilibria in particle simulation codes. By means of a simple modification to the field equation used to solve for the vector potential, a dissipative relaxation is added to the system. Coherent motion rapidly damps, and an equilibrium which is as quiet as the finite number of particles will allow evolves in a natural manner.

1983 (COO—3170-7, pp 51, Paper 11) **Stability of axisymmetric field-reversed equilibria of arbitrary ion gyro-radius.** Sudan, R.N.; Rosenbluth, M.N. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

An "energy principle" is developed that leads to sufficient conditions for treating the low frequency stability of axisymmetric, field-reversed equilibria, e.g., ion rings, theta-pinches and field reversed mirrors. Particles that carry the azimuthal current are described in the Vlasov formalism allowing for arbitrary gyroradius, while the background plasma is approximated by the two-fluid equations. Two special cases, viz., a long thin P-layer and a thin ion ring of large aspect ratio, are examined in detail.

1984 (COO—3170-7, pp 7p, Paper 12) **Ion ring equilibria with torodial magnetic field.** Sudan, R.N. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

Most of the published equilibria of field-reversed Astron E-layers, ion rings, theta-pinches, etc., analytically derived or obtained by numerical techniques, have been limited to configurations with only a poloidal magnetic field. Since there may be some stability advantage to including a toroidal field, we give a simple generalization of well known Vlasov equilibria with only poloidal field to those which include a toroidal field generated by internal plasma currents.

1985 (LA-UR—78-1963) **New results in high beta MHD theory.** Barnes, D.C.; Brackbill, J.U.; Cayton, T.E. (Los Alamos Scientific Lab., NM (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.; New York Univ., NY (USA). Courant Inst. of Mathematical Sciences). 1978. Contract W-7405-ENG-36. 19p. (CONF-780811—5). Dep. NTIS, PC A02/MF A01.

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

New results are described in the following three areas of high MHD theory: (1) equilibrium and stability of diffuse high-β stellarators, (2) MHD equilibrium and stability of minimum-B mirror traps, and (3) simulation of simple and reversed field mirror machines.

1986 (ORNL—5405, pp 75-119) **Plasma theory.** Callen, J.D.; Dory, R.A.; Amano, T. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

The progress during the past year is organized by group efforts and divided into six major areas. The basic tokamak areas and the sections in which their work is summarized are: MHD theory, kinetic theory, and transport simulation. The EBT theory work has its own research projects on MHD theory, kinetic theory, and transport simulation. In the plasma engineering area, relevant research work is further developed and synthesized into models that are used in the design of advanced fusion systems—TNS, Demo, EBTR, etc. Finally, the computer support activities during the past year are summarized.

1987 (ORNL/TM—6477) **User's guide to the CALVEC software library: a computer program for emulation of CALCOMP graphics on a Versatec printer/plotter.** Gray, W.H. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 33p. Dep. NTIS, PC A02/MF A01.

This document describes a set of FORTRAN subroutines collectively called the CALVEC subprogram library. The purpose of the CALVEC software library is the emulation of CALCOMP pen and ink graphics on a DECsystem 10. A user level interface with CALVEC software allows standard CALCOMP subprogram calls to produce a VECtor file, SEGMNT.VEC. This vector file may subsequently be postprocessed into an image in a variety of ways.

1988 (PPPL—1458) **ILUCG algorithm which minimizes in the Euclidean norm.** Petravic, M.; Kuo-Petravic, G. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1978. Contract EY-76-C-02-3073;W-7405-ENG-48. 16p. Dep. NTIS, PC A02/MF A01.

An algroithm is presented which solves sparse systems of linear equations of the form Ax = Y, where A is non-symmetric, by the Incomplete LU Decomposition-Conjugate Gradient (ILUCG) method. The algorithm minimizes the error in the Euclidean norm vertical bar x/sub i/ - x vertical bar$_2$, where x/sub i/ is the solution vector after the i/sup th/ iteration and x the exact solution vector. The results of a test on one real problem indicate that the algorithm is likely to be competitive with the best existing algorithms of its type.

1989 (PPPL—1462) **Plasma transport in stochastic magnetic fields. II. Principles and problems of test electron transport.** Krommes, J.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1978. Contract EY-76-C-03-3073. 17p. Dep. NTIS, PC A02/MF A01.

A model stochastic differential equation is considered which describes guiding center electron motion in a statistically specified spectrum of turbulent magnetic fluctuations. The fluctuation intensity is assumed to satisfy the Chirikov criterion (resonance overlap) for onset of stochasticity. In this limit typical lines diffuse and are adequately described by a quasilinear diffusion coefficient D/sub m/. However, quasilinear theory does not describe an important mechanism for loss of particle correlations: particles collisionally diffuse from one line to an adjacent one which diverges rapidly from the first, carrying the particles away. The scale length L/sub K/ for line divergence is related to the inverse of the Kolmogorov-Sinai entropy. An attempt is made to determine L/sub K/ from a simplified Eulerian vertex renormalization. The exponentiation length which emerges is L/sub K/ approximately L/sub s/(anti k^2/sub theta/D''/sub m/L/sub s/)/sup -1/3/, where L/sub s/ is the shear length, k bar/sub theta/ is a typical azimuthal wavenumber, and D''/sub m/ is of order D/sub m/. In a particular limit of weak shear, the particle diffusion coefficient can then be estimated as D approximately DELTA r^2/tau/sub c/, where Δr^2 approximately D/sub m/z(tau/

sub c/), z(tau) is the distance traveled along the lines in time tau, and for static fluctuations tau/sub c/ approximately tau(L/sub δ/), where L/sub delta/ is L/sub K/ multiplied by a logarithmic factor involving the perpendicular collisional diffusion coefficient.

1990 (UCID—17795(Rev.1)) **MAGIC: a one-dimensional magneto-inductive particle code.** Brengle, T.A.; Cohen, B.I. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Jul 1978. Contract W-7405-ENG-48. 46p. Dep. NTIS, PC A03/MF A01.

MAGIC, a new one-dimensional particle code, simulates magneto-inductive phenomena in a cylindrically-symmetric magnetized plasma. We describe the physical model and the computational algorithm used for the code. A user's guide to and a listing of MAGIC are also included.

1991 (UCRL—50051-78-1, pp 39-47) **Applied plasma physics.** 22 Apr 1978.

In Magnetic fusion energy quarterly report, January—March 1978.

Applied Plasma Physics is a major sub-organizational unit of the MFE Program. It includes Fusion Plasma Theory and Experimental Plasma Research. The Fusion Plasma Theory group has the responsibility for developing theoretical-computational models in the general areas of plasma properties, equilibrium, stability, transport, and atomic physics. This group has responsibility for giving guidance to the mirror experimental program. There is a formal division of the group into theory and computational; however, in this report the efforts of the two areas are not separated since many projects have contributions from members of both. Under the Experimental Plasma Research Program, we are developing the intense, pulsed neutral-beam source (IPINS) for the generation of a reversed-field configuration on 2XIIB. We are also studying the feasibility of utilizing certain neutron-detection techniques as plasma diagnostics in the next generation of thermonuclear experiments.

1992 (UCRL—81103) **Problem of unstable pivots in the incomplete LU-conjugate gradient method.** Kershaw, D.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Jun 1978. Contract W-7405-ENG-48. 13p. (CONF-780614—1). Dep. NTIS, PC A02/MF A01.

From 8. conference on numerical simulation plasma; Monterey, CA, USA (28 Jun 1978).

Incomplete LU and incomplete-Cholesky conjugate gradient methods are becoming widely used in both laser and magnetic fusion research. In my original presentation of these methods, the problem of what to do if a pivot (L/sub ii/U/sub ii/) becomes very small or zero was raised and only partially answered by the suggestion that it be arbitrarily set to some non-zero value. In what follows it will be shown precisely how small the pivot can become before it must be fixed and precisely what value it should be set to in order to minimize the error in LU. Numerical examples will be given to show that not only does this prescription improve incomplete LU-conjugate gradient methods , but exact LU decomposition carried out with this prescription for handling small pivots and followed by a few linear or conjugate gradient iterations can be much faster than the permutations of rows and columns usually employed to circumvent small pivot problems.

1993 **Kinetic theory of neutral hydrogen atoms in a bounded hydrogen plasma slab.** Burrell, K.H. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 12, 2202-2207(Dec 1978).

The transport of neutral hydrogen atoms in a hydrogen plasma slab is considered. After making a reasonable approximation for the charge exchange rate, analytic solutions for the neutral distribution function are obtained which depend on one spatial and three velocity variables. To obtain these, a condition must be imposed that implies uniform electron and ion temperatures. Specular reflection of the neutrals at the boundaries is considered. Solutions associated with the diffusion approximation are also given and the condition for its validity is discussed. The solutions are evaluated for the case of Maxwellian ion distribution functions.

1994 **Emission of radiation from a localized current source in a magnetoplasma.** Giles, M.J. (Sussex Univ., Brighton (UK). School of Mathematical and Physical Sciences). *J. Plasma Phys.;* **19**: 201-225(Apr 1978).

A new approach to the problem of the radiation emitted from a localized external current source embedded in a magnetoplasma is described. It is argued that the calculation of the fields in the radiation zone can be substantially simplified by adopting at the outset a suitable parametrization of the dispersion surface. The form of the surfaces of constant phase and the amplitudes of the emitted waves are described for each topologically different region of parameter space and their structures are related to the shapes of the refractive index surfaces. Attention is also drawn to the existence of locally cylindrical waves that can produce beams which are highly collimated in the direction of the external magnetic field.

1995 **Low frequency response of a resistive plasma to axially independent or axisymmetric perturbations.** Jensen, T.H.; Thompson, W.B. (General Atomic Co., San Diego, Calif. (USA)). *J. Plasma Phys.;* **19**: 227-235(Apr 1978).

A formalism is described which permits calculation of the low frequency response of a resistive plasma with non-circular cross-section in magnetohydrodynamic equilibrium to an externally imposed current field in the direction of the ignorable co-ordinate. This formalism is limited to slow variations on the resistive penetration or 'skin' time-scale and eliminates rapid motions at the hydrodynamic rate. It is useful for calculating the effectiveness of low frequency Ohmic heating and for the study of feedback stabilization. It also determines stability criteria and gives estimates of growth rates. The presence of a hyperbolic axis in the Doublet configuration makes the incorporation of a finite resistivity in the treatment important.

1996 **Calculation of a self-consistent, low frequency electrostatic field in the drift-kinetic approximation.** Beasley, C.O. Jr.; McCune, J.E.; Meier, H.K.; Van Rij, W.I. (Oak Ridge National Lab., Tenn. (USA)). *Plasma Phys.;* **20**: No. 2, 115-126(Feb 1978).

An asymptotic series in $\omega sub(p)^{-2}$, the inverse-square plasma frequency, is derived for the self-consistent, low frequency electrostatic field in tori. The derivation is consistent with the drift-kinetic ordering and may be used in either instability or equilibrium calculations. It is found that in a time-dependent formalism, the electric field is completely determined to first order in a drift-kinetic expansion.

1997 **Self-similar solutions for Vlasov and water-bag models.** Burgan, J.R.; Gutierrez, J.; Fijalkow, E.; Navet, M.; Feix, M.R. (Centre National de la Recherche Scientifique, 45 - Orleans-la-Source (France)). *J. Plasma Phys.;* **19**: 135-146(Feb 1978).

Using finite group theory, self-similar solutions for the one-dimensional Vlasov-Poisson system are considered, both for electron plasmas, with a fixed ion background, and for a single species beam. Difficulties arising from the Poisson equation are pointed out and handled by using an exponential group of transformations. Introducing, for the beam, a water-bag model, we find that the boundary condition problem, imposed by self-similarity, can be solved through the introduction of a 'virtual particle' concept. In order to test the analytical solution obtained, a numerical simulation using a particle code is performed. Complete agreement is found.

1998 **CO_2-laser induced X-ray emission from high density gaseous targets.** Krishan, S.; Krishan, V.; Sinha, K.P. (Indian Inst. of Science, Bangalore. Div. of Physics and Mathematical Sciences); Ganguli, A. *Plasma Phys.;* **20**: No. 2, 157-163(Feb 1978).

A theory for the emission of X-rays from a high density gaseous plasma interacting with CO_2 laser is given. It predicts a sharp increase in the X-ray intensity for densities close to the critical.

1999 **Effect of fluctuations on the response function of plasmas.** Cook, I. (UKAEA Research Group, Abingdon. Culham Lab.). *Plasma Phys.;* **20**: No. 1, 73-83(Jan 1978).

Turbulent, high density and low temperature plasmas are alike in having a non-negligible level of density fluctuations. A dielectric function of such plasmas is derived which incorporates both the self-correlation effects introduced by Dupree and the distinct particle correlation effects introduced by Ichimaru. Comparisons are made with theories of the response function of liquids.

2000 **Quasilinear acceleration of electrons by Langmuir waves in an inhomogeneous plasma.** Kovrizhnykh, L.M.; Sakharov, A.S. (AN SSSR, Moscow. Fizicheskij Inst.). *Fiz. Plazmy;* **2**: No. 1, 97-104(1976). (In Russian).

The paper deals with a self-consistent problem for the electron distribution function and the spectrum of Langmuir oscillations excited in an inhomogeneous plane plasma layer under the effect of, for instance, transverse waves, their frequency considerably exceeding that of the plasma. Steady-state solutions for spectra of particles and plasma oscillations have been found. The density of the accelerated electron flux and the mean square of their velocity are found. In a plasma while excitation of Langmuir oscillations with sufficiently large phase velocities by a source with the some space power.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 1936, 1949, 1950, 1985, 2094

2001 (COO—3170-7, pp 52p, Paper 1) **Precession and kink motion of long astron layers.** Lovelace, R.V. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

A study is made of the stability of the low-frequency precession and kink modes of a long astron particle layer embedded in a dense low-temperature plasma. Two types of precession of ion layers are discussed in detail. At relatively high frequencies there is a

precession mode with frequency ω approximately -(eta/sub e//2)Ω which shows the well-known negative energy type of instability for negative values of the effective external field index eta/sub e/. For low frequencies there is a magnetohydrodynamic precession mode with frequency ω approximately +- (eta/sub e//zeta)/sup ½/(v/sub A//anti v/sub theta/)Ω which is purely growing for eta/sub e/ less than 0. Here, Ω is the average circulation frequency for the layer particles; zeta is the loading factor, which is a measure of the layer strength; anti v/sub theta/ is the average azimuthal velocity of the layer ions; and v/sub A/ is the Alfven speed of the plasma. For the kink modes, a sufficient condition for stability is shown to be eta/sub S/ less than 3, where eta/sub S/ is the self-magnetic field index. For eta/sub S/ greater than 3 the kink motion is found to be purely growing.

2002 (COO—3170-7, pp 23p, Paper 5) **Ergodic behavior of lower hybrid decay wave ray trajectories in torodial geometry.** Wersinger, J.M.; Ott, E.; Finn, J.M. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

In cylindrical geometry, as a result of both magnetic shear and density gradient there exist radially trapped lower hybrid decay waves bouncing back and forth in the low density region of the plasma. If this situation persists in toroidal geometry, it could have a severely destabilizing effect on the nonresonant parametric decay of an externally launched lower hybrid heating wave. However, it is shown here that weak toroidicity causes some of these waves to follow ergodic ray trajectories, and hence to be detrapped and to reach their lower hybrid resonance. The fraction of waves which show ergodic behavior increases as the aspect ratio R_0/a decreases. For realistic aspect ratios, i.e., R_0/a less than or equal to 5, nearly all the rays are ergodic and energy flows toward the resonance. The consequences on lower hybrid wave heating are discussed.

2003 (COO—3170-7, pp 29p, Paper 7) **High frequency convective loss-cone instability in short mirror machines.** Gerver, M.J. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

The high frequency convective loss cone mode is found to be absolutely unstable even in short mirror machines when $\beta >$ or approximately m/sub e//m/sub i/, due to the exponentially small reflection of waves at the mirror throats. This result differs from that of previous calculations, which did not consider modes with k/sub perpendicular to/rho/sub i/ much less than (m/sub i//m/sub e/)/sup ½/, and which found instability only in long mirror machines (L/rho/sub i/ > or approximately to 100). Warm plasma can stabilize the modes only when the loss cone is almost completely filled.

2004 (COO—3170-7, pp 11p, Paper 12) **Resonant effects on the low frequency vlasov stability of axisymmetric field reversed configurations.** Finn, J.M.; Sudan, R.N. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

We investigate the effect of particle resonances on low frequency MHD modes in field-reversed geometries, e.g., an ion ring. It is shown that, for sufficiently high field reversal, modes which are hydromagnetically stable can be driven unstable by ion resonances. The stabilizing effect of a toroidal magnetic field is discussed.

2005 (GA-A—15006) **Suppression of plasma disruptions in tokamaks.** Ohyabu, N. (General Atomic Co., San Diego, CA (USA)). Jun 1978. Contract EY-76-C-03-0167-038. 31p. Dep. NTIS, PC A03/MF A01.

The adoption of a close fitting field-shaping coil system in tokamaks facilitates accurate plasma position and shape control for a broad range of plasma dynamics. This approach leads to minimization of the plasma-wall interaction, permitting low q operation of the tokamak discharge.

2006 (UCID—17876) **"Ballistic damping": a proposed method of stabilizing resonant ion cyclotron modes.** Post, R.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Jul 1978. Contract W-7405-ENG-48. 21p. Dep. NTIS, PC A02/MF A01.

The essence of the idea is as follows: One or more beams of energetic ions (or neutral atoms that will become ionized) are injected, parallel to the field lines, at radii where the instability electric field has maximum amplitude (say roughly halfway between the axis and the outer radius of the plasma). While in transit through the plasma these ions acquire transverse energy by resonant acceleration, thereby extracting energy from the wave. This imparted energy is then carried out of the confined plasma by the beam particles as they exit through the far mirror. In this way the ballistic damping process introduces a damping mechanism that can be used to inhibit the growth of unstable waves and/or to damp them out before they reach unacceptably high amplitude. It is also shown that the beam power required is substantially lower than the plasma powers involved, scaling in a favorable way with increase in the size of the mirror cell.

2007 (UCRL—81218) **Non-linear saturation of the tearing mode in a reversed field pinch.** Schnack, D.; Killeen, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1978. Contract W-7405-ENG-48. 23p. (CONF-780906—2). Dep. NTIS, PC A02/MF A01.

From Reversed field pinch workshop; Padua, Italy (4 Sep 1978).

A non-linear, two-dimensional, resistive MHD computer code was used to study the non-linear behavior of the m = 0, 1, and 2 tearing modes in a Reversed Field Pinch. For the cases m not equal to 0 we employ a coordinate transformation which assumes helical symmetry to reduce the dimensionality of the problem from three to two. We use the force-free Bessel function model equilibrium. We find that the most dangerous resistive instability in this case is the m = 1 tearing mode, due to its larger growth rate and extended period of exponential growth.

2008 (UCRL—81266) **Linear calculation of resistive instabilities in reversed field pinches.** Killeen, J.; Schnack, D.D.; Shestakov, A.I. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1978. Contract W-7405-ENG-48. 24p. (CONF-780906—1). Dep. NTIS, PC A02/MF A01.

From Reversed field pinch workshop; Padua, Italy (4 Sep 1978).

The time-dependent, linear, resistive magnetohydrodynamic, numerical models that have been developed at Livermore are briefly reviewed. The purpose of these codes is to compute growth rates and mode structure of tearing, rippling, and mixed modes in diffuse pinches. Cylindrical and Cartesian geometries are used in the applications. Results for the Reversed Field Pinch in cylindrical geometry are described, and the influence of other dissipative effects is considered. The double tearing mode is described as well as the effect of equilibrium flow on the tearing mode.

2009 **Cylindrical, axisymmetric magnetohydrodynamic turbulence.** Vahala, G. (Department of Physics, College of William and Mary, Williamsburg, Virginia 23185). *Phys. Fluids;* **21**: No. 12, 2167-2174(Dec 1978).

Incompressible magnetohydrodynamic turbulence is considered for an axisymmetric plasma in cylindrical geometry. The equilibrium statistical states to which the plasma evolves are examined by imposing an external constraint of constant toroidal current on the equilibrium Gibbs ensemble. Only the state with maximal magnetic helicity to energy ratio has zero-mean kinetic energy for intially quiescent systems. There is an upper bound on the toroidal current to toroidal flux ratio below which this unique stable force free state can exist and whose magnetic flux surfaces are basically concentric circles. Above this critical value, the plasma is unstable with islands present in the flux surfaces. This stability result is in sharp contrast with both the results of a linearized δW analysis as well as considering the stability of the linearized spectral coefficient evolution equations for nonforce-free states.

2010 **Nonlinear saturation of the dissipative trapped electron instability.** Migliuolo, S.; Simon, A. (Physics Department, University of Rochester, Rochester, New York 14627). *Phys. Fluids;* **21**: No. 12, 2218-2225(Dec 1978).

The nonlinear saturation amplitude of the dissipative trapped electron instability is calculated. Comparison is made with an experiment carried out in linear mirror geometry and near threshold, with only a single mode predominating. A model in which the untrapped electrons respond in a Boltzmann fashion yields good agreement. A model in which Landau damping is included predicts saturation amplitudes much smaller than observed. The first model seems appropriate for linear geometries while the second may apply to closed devices.

2011 **Bernstein waves, parametric instabilities, and magnetic shear.** Sperling, J.L. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 12, 2226-2229(Dec 1978).

The effect of magnetic shear on electrostatic Bernstein waves is investigated. It is shown that shear leads to nonlocal eigensolutions and the convective damping of the Bernstein waves. The threshold for the parametric instability of a magnetosonic wave into two Bernstein waves in a multispecies plasma is increased by shear. For a magnetosonic heating experiment conducted on a tokamak comparable to the Doublet III device at General Atomic, the parametric instability may still be excited despite the plasma inhomogeneities provided the pump wave amplitude exceeds a critical value to be estimated in this paper.

2012 **Universal drift instability from single-particle approach.** Chan, V.S.; Wong, S.K. (General Atomic Company, San Diego, California 92138). *Phys. Fluids;* **21**: No. 12, 2268-2270(Dec 1978).

An exact evaluation of the universal drift instability growth rate in a magnetic field with zero shear is presented. It is based on an asymptotic expansion of the energy equation for large time, in which the change in the kinetic energy of the plasma due to interaction with the wave is obtained from a single particle approach.

2013 Temperature gradient and electron gyroradius effects on lower hybrid drift-Drift cyclotron instabilities. McBride, J.B.; Hamasaki, S. (Laboratory for Applied Plasma Studies, Science Applications, Inc., La Jolla, California 92037). *Phys. Fluids;* **21**: No. 11, 1979-1982(Nov 1978).

Electron and ion temperature gradients, as well as finite electron gyroradius (krho/sub e/> or ≈1), have been retained to analyze the stability of electrostatic drift waves in the local approximation from the lower hybrid down to the ion cyclotron frequency. The instability conditions indicate the importance of these modes over this entire frequency range in a variety of applications.

2014 Ion temperature gradient driven drift cyclotron instabilities. Catto, P.J.; Aamodt, R.E. (Science Applications, Inc., Boulder, Colorado 80302). *Phys. Fluids;* **21**: No. 11, 1983-1985(Nov 1978).

The role of ion temperature gradient driven drift cyclotron instabilities in both mirror machines and tokamaks is examined. For a completely filled loss cone, reversed temperature and density gradients are necessary for instabilities; however, this inverted profile requirement is relaxed as the fill of the loss cone is decreased and all profiles are unstable for an empty loss cone.

2015 Stimulated Raman scatter in laser fusion target chambers. Thomson, J.J. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Fluids;* **21**: No. 11, 2082-2085(Nov 1978).

The target chamber of a laser fusion reactor will contain small amounts of background gases. As the beam is focused, it ionizes the gas and Raman scattering is induced. Density limits on the background gas are found in order that the laser beam not become appreciably decollimated. It is found that laser bandwidth efficiently decreases the scattering effect.

2016 Resonant effects on the low-frequency vlasov stability of axisymmetric field-reversed configurations. Finn, J.M.; Sudan, R.N. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Rev. Lett.;* **41**: No. 10, 695-698(4 Sep 1978).

We investigate the effect of particle resonances on low-frequency magnetohydrodynamic modes in field-reverse geometries, e.g., an ion ring. It is shown that, for sufficiently high field reversal, modes which are hydromagnetically stable can be driven unstable by ion resonances. The stabilizing effect of a toroidal magnetic field is discussed.

2017 Theory of universal eigenmodes in a sheared magnetic field. Chen, L.; Guzdar, P.N.; White, R.B.; Kaw, P.K.; Oberman, C. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **41**: No. 9, 649-653(28 Aug 1978).

Collisionless drift-wave eigenmodes in a sheared magnetic field are analyzed using the WKBJ method. It is found that, for L/ sub s//L/sub n/ > (L/sub s//L/sub n/)/sub c/, ion-sound dynamics determines the eigenvalues at small k/sub y/^{2} and the eigenmodes are damped. However, at large k/sub y/^{2}, electron dynamics dominates and the eigenmodes become marginally stable. For L/sub s// L/sub n/ < (L/sub s//L/sub n/)/sub c/, the eigenmodes are damped for all values of k/sub y/^{2}. The critical value (L/sub s//L/ sub n/)/sub c/ scales as (m/sub i//m/sub e/)/sup 1/4/.

2018 Excitation of convective cells by Alfven waves. Sagdeev, R.Z.; Shapiro, V.D.; Shevchenko, V.I. (Institute of Space Research, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 6, 340-344(20 Mar 1978).

A nonlinear mechanism is considered for the excitation of convective motions by Alfven waves. The parametric-instability growth rates corresponding to this process are determined and the coupled turbulence of the Alfven wave and of the convective mode is investigated. The question of excitation of convective cells by drift turbulence and of their influence on the anomalous diffusion of the plasma is also considered.

2019 Spatial distribution and extraction of ionic components of a rotating plasma in developed resonant ion-cyclotron instability. Vlasov, V.V.; Zalyubovskii, I.I.; Kirochkin, Y.A.; Krivonos, M.G.; Kryachko, Y.P.; Rozhkov, A.M.; Sosipatrov, M.V.; Stepanov, K.N.; Farenik, V.I. (Khar'kov State University). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 5, 247-250(5 Mar 1978).

Experimental observation of spatial and energy separation of different ionic components of a rotating plasma under stationary conditions is reported in the presence of ion cyclotron instability.

2020 Dynamic stabilization of the fire-hose instability. Cramer, N.F. (Sydney Univ. (Australia). School of Physics). *Plasma Phys.;* **20**: No. 2, 127-132(Feb 1978).

The oscillating pump magnetic field of a large amplitude magneto-acoustic wave propagating across a steady magnetic field is shown to stabilize the fire-hose instability occurring in a plasma with anisotropic pressure. The threshold for stabilization is calculated and found to be a minimum for spatial resonance of the pump wave.

2021 Propagation of energetic ion beams through a fusion target chamber. Jorna, S.; Thompson, W.B. (Physical Dynamics, Inc., La Jolla, Calif. (USA)). *J. Plasma Phys.;* **19**: 97-119(Feb 1978).

Aspects of the propagation of a highly energetic heavy ion beam through a fusion target chamber are considered. The stability of this beam to various perturbations is especially emphasized, first for vacuum propagation, and then for propagation through a background plasma. The results are illustrated by detailed calculations for a beam carrying 3kA of current and consisting of 70GeV, singly ionized uranium ions. It is found that such a beam will propagate stably through the target chamber. These calculations are applied to the recently proposed I^{53+} concept in which up to a hundred beams of 40 GeV iodine ions each carrying 4.2 kA of current are directed to the target. The conclusions for this case are less optimistic, as such beams are likely to be subject to space-charge problems due to the increased value of ν/γ and are prone to instabilities of the two-stream type.

2022 Parametric excitation of ion-cyclotron waves in a plasma containing two types of ions. Baikov, I.S. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). *Plasma Phys.;* **20**: No. 1, 85-89(Jan 1978).

Parametric decay instability of a pump wave with a frequency of the order of the ion cyclotron frequency and with a phase which undergoes a random walk is investigated for the case of a homogeneous plasma which consists of electrons and of two types of ions. Growth rate for the parametric decay instability has been found as a function of the ratio sub(γo)/D, where D is the diffusion coefficient and sub(γo) the linear growthrate of the parametric decay instability in a pump wave with fixed phase.

2023 Influence of a lower hybrid oscillation on the nonlinear development of the electron cyclotron instability in a beam-plasma system. Cabral, J.A.C.; Silva, M.E.F.; Varandas, C.A.F. (Instituto Superior Tecnico, Lisbon (Portugal). Lab. de Electrodinamica). *Plasma Phys.;* **20**: No. 1, 21-32(Jan 1978).

The sequence of bursts belonging to the electron cyclotron instability of a beam-plasma system is analysed by the experimental determination of its time-interval and amplitude statistics, which reveal the profound influence of a lower hybrid oscillation on the nonlinear development of the instability, for several interaction regimes.

2024 Problem of the decay instability of electromagnetic waves in a magnetoactive plasma. Roslyakov, V.A.; Starostin, A.N. (Nuclear Physics Research Institute of the Moscow State University). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 917-922(Nov 1977).

The processes of decay of transverse electromagnetic waves propagating across a constant magnetic field are considered. The possibility of using these decays for tuning the frequency of the stimulated radiation in the magnetoactive plasma of semiconductors, as well as for the diagnostics of the magnetic fields that spontaneously develop in a laser plasma is discussed.

2025 Real-space quasilinear theory of drift waves in a sheared magnetic field. Hatori, T.; Lee, Y.C. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Tange, T. *J. Phys. Soc. Jpn.;* **43**: No. 2, 655-661(Aug 1977).

A real-space quasilinear theory is developed for the collisional and the collisionless drift waves in a plasma with a sheared magnetic field of slab geometry. The equation obtained describes the interaction between many localized modes around differentrational surfaces through the density modulation of the energy source region of each mode. The wave amplitudes approach to the stationary values through a relaxation oscillation process. When the width x sub(s) of the energy source region becomes comparable to the spacing Δx of the two adjacent rational surfaces, diffusion coefficient due to the wave propagation is shown to be negligible compared to that associated with the diffusion process.

2026 Current instabilities and turbulent plasma acceleration. Aref'ev, V.I. *Zh. Tekh. Fiz.;* **46**: No. 4, 674-679(Apr 1977). (In Russian).

A nonlinear process which has been called "abnormal-resistance electrothermic explosion" has been studied. The process underlies the effect of fast particle generation observed in pulse high-current gas discharges. It has been demonstrated that the most important phenomena to be studied in turbulent electromagnetic plasma acceleration are instabilities of the transverse current, among which for example, the "modified two-stream instability", electron cyclotron-harmonics instability and the other instabilities of gas-

discharge plasma providing a substantial contribution to abnormal resistance can be mentioned. The energy of fast particles has been shown to depend upon the magnitude of the abnormal resistance of the discharge. The abnormal resistance arising from the current instabilities has been determined on the basis of an analogy between binary and collective collisions resulting in stabilization of the transverse current instabilities under consideration.

2027 Plasma drift instability in a closed plasma accelerators with an extended area of acceleration. Esipchuk, Yu.V.; Tilinin, G.N. *Zh. Tekh. Fiz.;* **46**: No. 4, 718-729(Apr 1977). (In Russian).

The theoretical study of plasma stability in an accelerator with closed drift and an extended zone of acceleration (ACD) which has been carried out in the linear approximation, has revealed the possibility of build-up of fast magnetosound waves by plasma inhomogeneities (the drift instability of magnetosound oscillations). Depending on conditions two types of oscillations of this kind can turn out instable, namely, "azimuthal" and "quasi-longitudinal" ones. The existence of HF azimuthal oscillations in the ACD (drift electron waves) has been shown experimentally. The oscillations appear as nonlinear disturbances propagating azimuthally at a velocity approaching that of electron drift. The quasi-longitudinal oscillations treated theoretically most of all correspond to "flight" oscillations.

2028 Parametric effects in interaction of an electron beam with a plasma. Al'terkop, B.A.; Volokitin, A.S.; Tarakanov, V.P. (AN SSSR, Moscow. Inst. Vysokikh Temperatur). *Dokl. Akad. Nauk SSSR;* **234**: No. 4, 806-809(1977). (In Russian).

The beam instability breakaway accompanied by strong modulation of the plasma density has been investigated, the breakaway arises in electron beam-plasma interaction. The nonlinear dynamics of the Langmuir field modulation instability excited by the beam is shown to lead to production of solitons irregularly distributed in a space and to strong density modulation which is not related to the field distribution. The state is characterized by plasmon high absorption which may result in the beam instability breakaway. The plasma bleaching for the beam is repeated periodically with the characteristic time determined by sound disturbances dissipation.

2029 Stability of high-frequency discharge non-equilibrium plasma in a transverse magnetic field. Amal'skaya, R.M.; Golubev, V.S.; Dan'shchikov, E.V.; Lebedev, F.V. (Moskovskij Gosudarstvennyj Univ. (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki). *Fiz. Plazmy;* **2**: No. 1, 91-96(1977). (In Russian).

The results of the experimental investigations are presented which show possibilities of using a capacitive high-frequency (HF) discharge on studying plasma in a magnetic field. The experiment with a non-equilibrium Ar-Cs plasma is carried out in sealed-off glass tubes. Plasma is produced by a HF electric field at 5 MHz. The experimental researches described demonstrate a number of methodical features of the HF discharge diagnostics, which, in particular, make it possible to observe visually stationary inhomogeneities, to investigate their dynamics without applying the methods of high-speed photography and, at last, to separate and investigate the topology of instabilities with the development time of the order of several seconds. The analysis of the development times and threshold values of magnetic fields and also the comparison with data available in literature have made it possible to divide them into two classes and to assume that the inhomogeneities have thermal and ionization nature.

2030 Hydromagnetic stability of a stratified fluid. Bhatia, P.K.; Gupta, P.N. (Jodhpur Univ. (India). Dept. of Mathematics). *Proc. Indian Natl. Sci. Acad., Part A;* **43**: No. 1, 68-81(1977).

The dynamic stability of a rotating viscous hydromagnetic fluid configuration of variable density has been investigated to include the combined influence of the effects of the finiteness of the ion Larmor radius (F.L.R.) and finite magnetic resistivity. The prevalent magnetic field is assumed to be uniform and vertical. A variational principle is shown to characterize the problem. Making use of the existence of the variational principle, an explicit solution has been obtained for a semi-infinite fluid layer in which the density varies exponentially along the vertical. It is found that the magnetic resistivity has a destabilizing influence while the coriolis forces, viscosity and F.L.R. exhibit the stabilizing character.

2031 Plasma stability region in a ring tokamak. Bortnikov, A.V.; Brevnov, N.N.; Gerasimov, S.N.; Zhukovskii, V.G.; Pergament, V.I.; Khimchenko, L.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). *Fiz. Plazmy;* **3**: No. 2, 200-208(1977). (In Russian).

An experimental study has been made into the region of stability of the plasma in the T-9 finger-ring tokamak in coordinates of discharge current-mean plasma density. It has been found that the stability region has three boudaries, just as in a conventional tokamak. Processes occurring on the left (low plasma density) and upper (plasma maximum current) bondaries of the stability region in a conventional and finger-ring tokamaks are generally similar. The processes on the right boundary of the stability region are due to the instability of the critical density and in some parameters dissimilar. For example, in contrast to a conventional tokamak the instability in a finger-ring tokamak is characterized by broadening of the current channel of the plasma filament and by a different relationship between the boundary and the plasma density. The differences seem to be associted with the development of a balloon instability.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 1933, 2024

2032 Existence of rarefaction shocks in a laser-plasma corona. Bezzerides, B.; Forslund, D.W.; Lindman, E.L. (Laser Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Fluids;* **21**: No. 12, 2179-2185(Dec 1978).

General conditions under which rarefaction shocks can exist in the expanding corona of a plasma heated by a laser are derived. In particular, for the case of a two-electron temperature isothermal plasma with temperatures T/sub h/ and T/sub c/, such a shock is shown to occur if T/sub h//T/sub c/>5+$\sqrt{24}$. The case of rarefaction shocks induced by the ponderomotive force is also briefly discussed.

2033 Stochastic acceleration by an obliquely propagating wave-An example of overlapping resonances. Smith, G.R.; Kaufman, A.N. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Fluids;* **21**: No. 12, 2230-2241(Dec 1978).

A simple problem exhibiting intrinsic stochasticity is treated: the motion of a charged particle in a uniform magnetic field and a single plane wave. Detailed studies of this wave-particle interaction show the following features. An electrostatic wave propagating obliquely to the magnetic field causes stochastic motion if the wave amplitude exceeds a certain threshold. The overlap of cyclotron resonances then destroys a constant of the motion, allowing appreciable momentum transfer to the particles. A wave of large enough amplitude would thus suffer severe damping and lead to rapid heating of a particle distribution. The stochastic motion resembles a diffusion process even though the wave spectrum is monochromatic. The methods of this paper should be useful for other problems showing stochasticity such as superadiabaticity in mirror machines, destruction of magnetic surfaces in toroidal systems, and lower hybrid heating.

2034 Phase-locked particle motion in a large-amplitude plasma wave. Smith, G.R.; Pereira, N.R. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **21**: No. 12, 2253-2262(Dec 1978).

A plasma wave with an oscillating amplitude and phase occurs in two commonly studied situations, the beam-plasma interaction and the launching of a large-amplitude wave in a Maxwellian plasma. Electron motion in such a wave is either regular or stochastic. Theoretical study shows that regular motion can exhibit a phase-locking effect, which explains the persistence of amplitude oscillations observed in simulations and experiments. An additional ("test") wave of moderate amplitude can prevent phase-locking, causing stochastic motion instead, and thereby destroy the amplitude oscillations. The effects studied are also relevant to the theory of sideband instability.

2035 Ergodic behavior of lower hybrid decay wave ray trajectories in toroidal geometry. Wersinger, J.; Ott, E.; Finn, J.M. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Fluids;* **21**: No. 12, 2263-2267(Dec 1978).

In cylindrical geometry, as a result of both magnetic shear and density gradient there exist radially trapped lower hybrid decay waves bouncing back and forth in the low density region of the plasma. If this situation persists in toroidal geometry, it could have a severely destabilizing effect on the nonresonant parametric decay of an externally launched lower hybrid heating wave. However, it is shown here that weak toroidicity causes some of these waves to follow ergodic ray trajectories, and hence to be detrapped and to reach their lower hybrid resonance. The fraction of waves which shows ergodic behavior increases as the aspect ratio R_0/a decreases. For realistic aspect ratios, i.e., $R_0/a <$ or ≈ 5, nearly all the rays are ergodic and energy flows toward the resonance. The consequences for lower hybrid wave heating are discussed.

2036 Damping of resonance cones in lower hybrid mode conversion. Grabbe, C.L. (California Institute of Technology, Pasadena, California 91125). *Phys. Fluids;* **21**: No. 11, 1976-1978(Nov 1978).

The asymptotic form of the collisional and collisionless damping of the potential for the resonance cones propagating into and out of the lower hybrid layer is obtained, and the localization of the various damping mechanisms along the cone is discussed. It is found that the damping of the incoming cone is not as large as previously predicted.

2037 Cross field thermal transport due to ion acoustic waves in weakly magnetized plasmas. Manheimer, W.M.; Max, C.E.; Thomson, J. (Naval Research Laboratory, Washington, D. C. 20375). *Phys. Fluids;* **21**: No. 11, 2009-2013(Nov 1978).

It is shown that cross field temperature gradients can drive ion acoustic waves unstable in a weakly magnetized plasma. The principal effect of the instability is an enhancement of the cross field thermal conductivity.

2038 Magnetostatic mode and cross-field electron transport. Chu, C.; Chu, M.; Ohkawa, T. (General Atomic Company, San Diego, California 92138). *Phys. Rev. Lett.;* **41**: No. 9, 653-656(28 Aug 1978).

A zero-frequency magnetostatic mode is shown to exist in a magnetized plasma. This mode resembles the two-dimensional electrostatic convective-cell mode in many ways. Electron cross-field test-particle diffusion due to thermally excited magnetostatic modes exhibits the Bohm-like T/B behavior. This mode would enhance the electron heat and momentum transport and could permit rapid spreading of plasma current.

2039 Drift Alfven waves in tokamaks. Tsang, K.T.; Whitson, J.C.; Callen, J.D.; Catto, P.J.; Smith, J. (Fusion Energy Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **41**: No. 8, 557-561(21 Aug 1978).

A new branch of solutions of the finite-beta drift-wave radial eigenmode equations has been found. The branch is heavily damped in the low-beta regime and identified with the shear Alfven wave. This branch and the usual electrostatic branch are damped in a collisionless plasma. Including trapped electron effects an introduces an instability which is potentially harmful to plasma confinement.

2040 Relaxation of initial perturbation and Landau damping in an inhomogeneous plasma. Dikman, S.M. (Institute of Physics Problems, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 8, 403-407(20 Apr 1978).

The relaxation of plasma oscillations in a weakly inhomogeneous anisotropic collisionless plasma is considered. The damping of the Langmuir waves is investigated in detail. The Landau-damping decrement increases exponentially with time, owing to the linear growth of the characteristic wave vector with time.

2041 Excitation of lower hybrid waves by electron beams in finite geometry plasmas. Pt.2. Surface waves. Gagne, R.R.J.; Shoucri, M.M. (Laval Univ., Quebec City (Canada). Dept. of Electrical Engineering). *J. Plasma Phys.;* **19**: 295-299(Apr 1978).

The dispersion relations for the quasi-static lower hybrid surface waves are derived. Conditions for their existence and their linear excitation by a small density electron beam are discussed. Instabilities appearing in low-frequency surface waves are also discussed.

2042 Influence of polarization of vacuum in a magnetic field on the propagation of radiation in a plasma. Gnedin, Y.N.; Pavlov, G.G.; Shibanov, Y.A. (A. F. Ioffe Physicotechnical Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **27**: No. 6, 305-309(20 Mar 1978).

It is shown that the polarization of vacuum by a strong magnetic field leads to a substantial change in the polarization, in the angular distribution, and in the emission spectrum of a magnetoactive plasma.

2043 Effect of cold electrons on linear and nonlinear ion acoustic waves. Goswami, B.N.; Sinha, M. (Physical Research Lab., Ahmedabad (India)). *Plasma Phys.;* **20**: No. 1, 91-93(Jan 1978).

The effect of cold neutrons on linear and nonlinear ion acoustic waves is considered. It is found that as the cold electron density increases the strength of its nonlinearity increases and above the critical value it takes over the ion nonlinearity.

2044 Nonlinear theory of the low-frequency oscillations in a weakly turbulent plasma. Akhiezer, A.I.; Aleksin, V.F.; Khodusov, V.D. (Physico-technical Institute, Ukrainian Academy of Sciences). *Sov. Phys. - JETP (Engl. Transl.);* **46**: No. 5, 922-927(Nov 1977).

A theory is developed for determining the frequency shift of electromagnetic waves in a weakly turbulent plasma as a function of the level of the turbulent pulsations. The case of magnetohydrodynamic waves is considered. It is shown that the dispersion laws for Alfven and slow magnetosonic waves change markedly at low values of the longitudinal (parallel to the magnetic field) component of the wave vector. Modified dispersion laws are obtained for them and these are taken into account in a study of relaxation processes of excitations in the wave spectra.

2045 Contribution of higher order terms in the reductive perturbation theory, 2. A case of strongly dispersive wave. Ichikawa, Y.H. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Mitsuhashi, T.; Konno, K. *J. Phys. Soc. Jpn.;* **43**: No. 2, 675-683(Aug 1977).

Contribution of higher order terms in the reductive perturbation theory has been investigated for nonlinear propagation of strongly dispersive ion plasma wave. The basic set of fluid equation is reduced to a coupled set of the nonlinear Schroedinger equation for the first order perturbed potential and a linear inhomogeneous equation for the second order perturbed potentialy. A steady state solution of the coupled set of equations has been solved analytically for the case of nonlinear amplitude modulation of the ion acoustic wave, which is nothing but the small wave number limit of the strongly dispersive ion plasma wave.

2046 Dynamical processes of the dressed ion acoustic solitons. Konno, K.; Mitsuhashi, T. (Nihon Univ., Tokyo. Dept. of Physics); Ichikawa, Y.H. *J. Phys. Soc. Jpn.;* **43**: No. 2, 669-674(Aug 1977).

Dynamical processes of the dressed ion acoustic solitons have been numerically analyzed by solving the coupled set of the first order Korteweg-de Vries equation and the second order equation, which has been derived on a basis of the reductive perturbation theory. A single soliton dressed by clouds of the second order perturbation potential exhausts ion acoustic wave behind when it travels down free space. On the other hand, in collision processes of two dressed solitons, the clouds around the Korteweg-de Vries soliton core redistribute themselves in such a way to equalize the heights of colliding pairs. Structure of the clouds suggests that effective attractive interaction acts between the colliding pairs of the dressed solitons.

2047 Cyclotron absorption of fast magnetosound waves in a plasma with the presence of a small group of resonance ions. Klima, R. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu); Longinov, A.V.; Stepanov, K.N. (AN Ukrainskoj SSR, Kharkov. Fiziko-Tekhnicheskij Inst.). *Zh. Tekh. Fiz.;* **46**: No. 4, 704-708(Apr 1977). (In Russian).

On the basis of the linear theory the attenuation of fast magnetosound waves in a plasma caused by cyclotronic absorption of the waves by resonance ions of a low-density admixture introduced into the plasma has been investigated. It has been shown that in such a case the wave attenuation can be strong even at a low density of admixture ions.

2048 Transverse and longitudinal waves interactions in a strongly turbulent plasma. Komilov, K.; Khakimov, F.Kh.; Tsytovich, V.N. (Tadzhikskij Gosudarstvennyj Univ., Dushanbe (USSR)); Stenflo, L. (Umeaa Univ. (Sweden)). *Zh. Tekh. Fiz.;* **46**: No. 4, 680-688(Apr 1977). (In Russian).

The interaction between transverse and longitudinal waves in a high-turbulent isotropic plasma has been studied. It has been demonstrated that in the presence of the langmuir condensate this interaction is enhanced. The expression for the enhancement coefficient has been derived.

2049 Attenuation of acoustic waves through reflections at the plasma neutral gas interfaces: weakly ionised case. Ghosal, S.K.; Sen, S.N. (North Bengal Univ., Darjeeling (India). Dept. of Physics). *Proc. Indian Natl. Sci. Acad., Part A;* **43**: No. 2, 96-104(1977).

The problem of transmission of sonic waves through a weakly ionised plasma bounded in each side by a neutral gas medium has been treated by assuming the plasma to be a mixture of two intermingled fluids viz., neutral particle fluid and ion fluid in equilibrium. From a hydrodynamic analysis the wave equation for 'p', the macroscopic pressure perturbation has been obtained and it is shown that two independent wave motions, one due to the neutral particles and the other due to ions are propagated through the plasma with two different phase velocities. Assuming the usual boundary conditions at the interface, the amplitude of the transmitted wave has been calculated in case of weakly ionized plasma; the theory can be utilized for the determination of electron temperature from the measured value of attenuation if the percentage of ionization and collision cross section can be obtained independently.

2050 Structure of a long-wave Langmuir oscillation spectrum in an inhomogeneous plasma. Breizman, B.N.; Ryutov, D.D.; Sobolev, O.P. (AN SSSR, Novosibirsk. Inst. Yadernoj Fiziki). *Fiz. Plazmy;* **2**: No. 1, 86-90(1976). (In Russian).

The problem has been solved on the structure of a stationary spectrum of Langmuir oscillations established under the action of two counteracting factors: 1) spectral over pumping of oscillations into the range of low values of the wave vector k because of induced scattering on plasma ions and 2) an increase of the wave vector due to plasma density inhomogeneity. The stationary spectrum presents a narrow peak in the k-space. The position of the peak k_0 and its width are related to the complete energy of oscillations. The result obtained shows that the plasma inhomogeneity prevents from the production of a condensate at the point $k=0$ and permits the presence of the stationary spectrum not subjected to modulation instability.

2051 Maximum amplitude of a HF field in the plasma resonance region. Bulanov, S.V.; Kovrizhnykh, L.M. (AN SSSR, Moscow. Fizicheskij Inst.). *Fiz. Plazmy;* 2: No. 1, 105-112(1976). (In Russian).

Interaction of a high-frequency electromagnetic field with an inhomogeneous plasma is investigated. The plasma is described in the hydrodynamic approximation. Nonlinear forced Langmuir oscillations are considered. It has been shown that the nonlinear mechanisms of the electron trajectory self-intersection type arising due to plasma inhomogeneity or on allowing for relativistic effects may result in limitation of the electromagnetic field amplitude in the region of plasma resonance. For the case of a cold collisionless plasma maximum values of a field amplification in resonance have been found. The role of the ion motion is qualitatively investigated.

2052 Finite amplitude Langmuir oscillations in a plasma resonance region. Bulanov, S.V.; Kovrizhnykh, L.M.; Sakharov, A.S. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Eksp. Teor. Fiz.;* 72: No. 5, 1809-1923(May 1973). (In Russian).

Stimulated Langmuir oscillations of an inhomogeneous plane plasma layer in an external harmonic h.f. field are considered in the multi-fluid hydrodynamics approximation. Restriction of the electric field amplitude near the plasma resonance point is investigated which is due to linear transformation into plasma waves, self-intersection of electron trajectories, anharmonism of Langmuir oscillations and nonstationarity of the plasma for various density profiles. Generation of plasma waves and acceleration of particles on wave-breaking of resonance leading to efficient dissipation of the oscillation energy in the resonance region are studied numerically. The role of ion motion induced by striction forces is analyzed qualitatively. The conditions are indicated under which modulation, parametric etc. instabilities related to ion movement, are negligible.

FUSION POWER PLANT TECHNOLOGY

2053 (CONF-780491—1) **Technological implications of fusion power: requirements and status.** Steiner, D. (Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

From Symposium on fusion energy; Montreal, Quebec, Canada (11 Apr 1978).

The major technological requirements for fusion power, as implied by current conceptual designs of fusion power plants, are identified and assessed relative to the goals of existing technology programs. The focus of the discussion is on the tokamak magnetic confinement concept; however, key technological requirements of mirror magnetic confinement systems and of inertial confinement concepts will also be addressed. The required technology is examined on the basis of three general areas of concern: (a) the power balance, that is, the unique power handling requirements associated with the production of electrical power by fusion; (b) reactor design, focusing primarily on the requirements imposed by a tritium-based fuel cycle, thermal hydraulic considerations, and magnet systems; and (c) materials considerations, including radiation damage effects, neutron-induced activation, and resource limitations.

2054 (LBL—7500) **Tormac confinement, theory, and experiment.** Berk, H.L.; Brown, I.G.; Feinberg, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1978. Contract W-7405-ENG-48. 3p. (CONF-780811—11). Dep. NTIS, PC A02/MF A01.

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

Tormac is a stuffed toroidal line cusp: the magnetic field is divided into two distinct regions, i.e., an outside "sheath" layer where the plasma is mirror-confined on open field lines and an internal high-β region of closed nested flux surfaces. The sheath is arranged with the appropriate curvature to ensure absolute MHD stability everywhere. The bulk of the plasma is maintained on closed flux surfaces as in a typical toroidal configuration, but with enhanced MHD stability due to the external field shaping. Experimental results on a toroidal "bicusp" (Tormac IV) will be reported. This device has a boro-silicate glass chamber and holds a plasma with an aspect ratio of 4 and a major diameter of 35 cm.

2055 (ORNL—5405) **Fusion Energy Division annual progress report for period ending 31 December 1977.** (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 251p. Dep. NTIS, PC A12/MF A01.

Separate abstracts were prepared for 10 of the included sections. (MOW)

2056 (ORNL—5405, pp 167-198) **Advanced systems.** Steiner, D.; Roberts, M.; Attenberger, S.E. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

The Advanced Systems Program includes three major activities: (1) the TNS program, (2) the Fusion Power Demonstration Study, and (3) the ELMO Bumpy Torus Reactor (EBTR) Study.

2057 (PPPL—1441) **Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.** (Princeton Univ., NJ (USA). Plasma Physics Lab.). May 1978. Contract EY-76-C-02-3073. 150p. (PH-R—006; CONF-780588—). Dep. NTIS, PC A07/MF A01.

From Information meeting; Princeton, NJ, USA (9 May 1978).

Separate abstracts were prepared for 23 of the included sections. (MOW)

2058 (PPPL—1441, pp 1.1-1.8) **Status report on TFTR.** Reardon, P.J. (Princeton Univ., NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The primary functions of the TFTR are described. Other topics outlined are the following: design requirements, performance requirements. project organization, cost estimate, schedule, and main engineering features. Some future planning is mentioned. (MOW)

2059 (UCRL—50051-78-1) **Magnetic fusion energy quarterly report, January—March 1978.** Harrison, M.A.; McGregor, C.K. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Apr 1978. Contract W-7405-ENG-48. 60p. Dep. NTIS, PC A04/MF A01.

Separate abstracts were prepared for each of the three included sections. (MOW)

2060 (UCRL—50051-78-1, pp 1-21) **Open confinement systems.** 22 Apr 1978.

In Magnetic fusion energy quarterly report, January—March 1978.

There are three confinement systems now in operation or under construction at LLL: the 2XIIB, the Tandem Mirror Experiment (TMX), and the Mirror Fusion Test Facility (MFTF). 2XIIB relies on magnetic fields to confine a hot, dense plasma for a short time. It features C-shaped magnetic coils that form the confining magnetic field. Their unique shape (in what is known as a yin-yang geometry) stabilizes the confined plasma by creating a magnetic field (a magnetic well) that increases in every direction from the plasma center. In 1976, we proposed a new idea: the tandem mirror concept. A tandem mirror reactor would contain a long solenoidal magnet terminated at both ends by conventional mirror cells. These cells would ace as "end plugs" to prevent plasma leakage out the ends of the solenoid. The TMX is being constructed to test the principles of this concept. The MFTF now being constructed will bridge the physics and engineering gaps between present experiments and an experimental fusion reactor planned for operation by 1990. The MFTF will use a superconducting magnet of yin-yang design (similar to the 2XIIB experiment). This magnet will be capable of continuous operation.

2061 (UCRL—52478) **Reference design for the standard mirror hybrid reactor.** Bender, D.J.; Fink, J.H.; Galloway, T.R.; Kastenberg, W.E.; Lee, J.D.; Devoto, R.S.; Neef, W.S. Jr.; Schultz, K.R.; Culver, D.W.; Rao, S.B.; Rao, S.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.; General Atomic Co., San Diego, CA (USA)). 22 May 1978. Contract W-7405-ENG-48. 550p. (GA-A—14796). Dep. NTIS, PC A23/MF A01.

This report describes the results of a two-year study by Lawrence Livermore Laboratory and General Atomic Co. to develop a conceptual design for the standard (minimum-B) mirror hybrid reactor. The reactor parameters have been chosen to minimize the cost of producing nuclear fuel (^{239}Pu) for consumption in fission power reactors (light water reactors). The deuterium-tritium plasma produces approximately 400 MW of fusion power with a plasma Q of 0.64. The fast-fission blanket, which is fueled with depleted uranium and lithium, generates sufficient tritium to run the reactor, has a blanket energy multiplication of M = 10.4, and has a net fissile breeding ratio of Pu/n = 1.51. The reactor has a net electrical output of 600 MWe, a fissile production of 2000 kg of plutonium per year (at a capacity factor of 0.74), and a net plant efficiency of 0.18. The plasma-containment field is generated by a Yin-Yang magnet using NbTi superconductor, and the neutral beam system uses positive-ion acceleration with beam direct conversion. The spherical blanket is based on gas-cooled fast reactor technology. The fusion components, blanket, and primary heat-transfer loop components are all contained within a prestressed-concrete reactor vessel, which provides magnet restraint and supports the primary heat-transfer loop and the blanket.

2062 (UCRL—80566) **Small mirror fusion reactors.** Carlson, G.A.; Schultz, K.R.; Smith, A.C. Jr. (California Univ., Livermore

(USA). Lawrence Livermore Lab.). 26 May 1978. Contract W-7405-ENG-48. 16p. (CONF-780508—46). Dep. NTIS, PC A02/MF A01.

From 3. meeting on the technology of controlled thermonuclear fusion; Santa Fe, NM, USA (9 May 1978).

Basic requirements for the pilot plants are that they produce a net product and that they have a potential for commercial upgrade. We have investigated a small standard mirror fusion-fission hybrid, a two-component tandem mirror hybrid, and two versions of a field-reversed mirror fusion reactor—one a steady state, single cell reactor with a neutral beam-sustained plasma, the other a moving ring field-reversed mirror where the plasma passes through a reaction chamber with no energy addition.

2063 (UCRL—81545) **Survey of mirror machine reactors.** Condit, W.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Aug 1978. Contract W-7405-ENG-48. 48p. Dep. NTIS, PC A03/MF A01.

The Magnetic Mirror Fusion Program is one of the two mainline fusion efforts in the United States. Starting from the simple axisymmetric mirror concept in the 1950's, the program has successfully overcome gross flute-type instabilities (using minimum-B magnetic fields), and the most serious of the micro-instabilities which plagued it (the drift-cyclotron loss-cone mode). Dense plasmas approaching the temperature range of interest for fusion have been created (n/sub p/ = 10^{14}/cc at 10 to 12 keV). At the same time, rather extensive conceptual design studies of possible mirror configurations have led to three principle designs of interest: the standard mirror fission-fusion hybrid, tandem mirror, and the field-reversed mirror. The lectures will discuss these three concepts in turn. There will be no discussion of diagnostics for the mirror machine in these lectures, but typical plasma parameters will be given for each type of machine, and the diagnostic requirements will be apparent. In a working fusion reactor, diagnostics will be required for operational control, and remarks will be made on this subject.

2064 (WFPS-TME—086) **Preliminary conceptual design of a Demonstration Tokamak Hybrid Reactor (DTHR). Status report, January 1978—March 1978.** Kelly, J.L. (ed.). (Westinghouse Electric Corp., Pittsburgh, PA (USA). Fusion Power Systems Dept.). Mar 1978. Contract EG-77-C-02-4544. 396p. Dep. NTIS, PC A17/MF A01.

The DTHR preliminary conceptual design consists of a magnetically confined fusion reactor fitted with a fertile thorium blanket. The fusion driver concept is based on a beam driven plasma, but at sufficiently high plasma densities that neutrons originating from the interactions of bulk plasma ions contribute significantly to the wall loading. The tokamak has a major radius of 5.2 m, a minor radius of 1.2 m, and the elongation is 1.6. All of the magnetic coil systems are superconducting Nb_3Sn based on the Large Coil Project (LCP) technology. The toroidal field (TF) coils employ an innovative concept, the "compact D" configuration. An engineered bundle divertor concept has been developed based on the bundle divertor design techniques developed for TNS and ISX-B. A thermal power of 150MW of 200 keV deuterium is injected into the plasma through six ducts of a positive ion, neutral beam injection system (NBIS). A water cooled, 316 stainless steel vacuum vessel concept was developed and initial scoping analyses look encouraging. The fusile fuel handling system was evaluated and defined. Details of the tritium injection system remain to be developed. Tritium breeding will be assessed in subsequent phases of the DTHR operation. The fusion driver provides a neutron first wall loading of 2MW/m^2 for fissile production in the blanket.

2065 **Gas-component analysis of laser fusion targets.** Schneggenburger, R.G.; Updegrove, W.S.; Nolen, R.L. Jr. (KMS Fusion, Inc. Ann Arbor, Michigan 48106). *Rev. Sci. Instrum.;* **49**: No. 11, 1543-1544(Nov 1978).

A gas-chromatographic method for analyzing the fuel content of laser fusion targets has been developed. It provides information on isotope ratios in the fuel gas, percent of molecular species, and total pressure of fuel gas in individual targets to a limit of 0.2 ng DT. The method can also be used to quantify other gaseous components not active in the thermonuclear process (e.g., H_2, He, etc.).

2066 **Fiscatron fusion reactor concept.** Fischer, A.G. (Dortmund Univ. (Germany, F.R.). Abt. Elektrotechnik). *Kerntechnik;* **20**: No. 4, 182-184(Apr 1978).

From 2. colloquium on plasma physics with a view towards fusion; Juelich, Germany, F.R. (25 - 26 Apr 1977).

A compact Z-pinch device is proposed that produces controlled microexplosions in solid-state-density ^{6}LiD (hydrogen bomb material). The ^{6}LiD is used as a fuel as tamping material, as moderator and neutron absorber. This reactor has no first inner wall. Tritium is its only radioactive byproduct. It can be tested in various stages quite inexpensively. It holds promise as a small, decentralized power source.

BLANKET ENGINEERING

2067 (GA-A—15005) **Model of plasma-limiter interaction.** Ohyabu, N. (General Atomic Co., San Diego, CA (USA)). Jun 1978. Contract EY-76-C-03-167-038. 15p. Dep. NTIS, PC A02/MF A01.

It is suggested that the plasma limiter interaction involves a non-uniform scrape-off of the plasma current, inducing helical current channels and hence the formation of magnetic islands. Since the outer magnetic surfaces are destroyed in such a picture, plasma-limiter interaction can make a substantial impact on global plasma properties.

2068 (PPPL—1441, pp 2.29-2.37) **Thermostructural and mechanical aspects of the TFTR plasma limiter design.** Condolff, R.; Fixler, S. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

This paper presents the preliminary mechanical and thermostructural aspects of the TFTR (TOKAMAK Fusion Test Reactor) plasma limiter design. The evolution of the limiter design is traced through the various stages from conceptual design to the present state. Results of parametric limiter blade studies are presented. Design criteria, requirements, design loads (mechanical and thermal), material considerations, and remote handling problems are described. The design approach used to achieve a satisfactory plasma limiter and blade is discussed.

2069 **Self-adjusting laser—target system for laser fusion.** Kruzhilin, Y.I. *Sov. J. Quant. Electron. (Engl. Transl.);* **8**: No. 3, 359-363(Mar 1978).

An analysis is made of methods of increasing the radiation density in laser fusion facilities. The utilization of wavefront reversal by a stimulated-Brillouin-scattering (STBS) mirror substantially reduces the requirements for the manufacturing precision of the optical components, structural rigidity, and target feed precision. A detailed analysis is made of the optical and energy characteristics of such a system. Estimates show that a target chamber of $\sim$1.5 m radius can be used with a focusing zone of $\sim 10^{-3}$ cm diameter.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 1163, 2067

2070 (COO—3170-7, pp 35p, Paper 4) **Equilibria of field reversed ion rings.** Finn, J.M.; Sparks, L. (Cornell Univ., Ithaca, NY). [nd].

In Theoretical studies on plasma heating and confinement. Progress report, 16 October 1977—15 October 1978.

Numerical computations of axisymmetric, two dimensional rigid rotor equilibria for field reversed ion rings are presented. A new numerical method, based upon Newton's method, is introduced and compared with earlier methods. Several new classes of equilibria, which are difficult if not impossible to find by earlier methods, are computed. These include solutions with two rings of current, a configuration which should occur in the evolution of a tearing mode of a long layer.

2071 (ORNL—5405, pp 145-166) **LCP and superconducting magnet technology.** Lubell, M.S.; Haubenreich, P.N.; Akin, J.E. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

In this year our efforts were focused primarily in support of the LCP and in advanced development of superconductor. We also carried out smaller but important design tasks in support of the TNS, EBT-S, EBT-II, and EBTR programs. The instrumentation development concentrated on testing of strain gages and evaluating the previously developed MCDT on a real system, ISX-A. New facilities were designed and construction initiated to enable us to evaluate properly the full-size conductor chosen by the three LCP participants. Capital facilities such as power supplies, a computer, and a large refrigerator/liquefier were received. The structural analysis and 3-D eddy current and magnetic field code development carried out in support of the ongoing projects also provided an extended capability for the future. A major effort was expended on getting the LCSTF set up. Practice winding of the first segment coil was completed and plans were formulated for winding the subsequent coils.

2072 (PPPL—1441, pp 2.21-2.28) **Development of high-mechanical strength electrical insulations for tokamak toroidal field coils.** Burke, C. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The electrical insulation for the TF (Toroidal Field) coils is subjected to high interlaminar shear, tensile and compressive stresses. Two candidate epoxy/glass fiber systems using prepreg and vacuum impregnation techniques were evaluated. Specimens were prepared and processed under controlled conditions to simulate specification manufacturing procedures. The strengths of the insulation were measured in interlaminar shear, tension, compression, and combined shear and compression statically. Shear modulus determinations were also made. Various techniques of surface treatments to increase bond strengths with three resin primers were tested.

2073 (PPPL—1441, pp 3.1-3.3) **Toroidal field (TF) coil case fatigue testing status report: April 28, 1978.** Frauenberger, H. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

A study was conducted to determine the feasibility of utilizing various cold working techniques in the TF coil case bolted joint. Several candidate methods were tested to determine the relative fatigue life improvements attainable. Half-scale tests were also conducted.

2074 (UCRL—50051-78-1, pp 22-38) **Development and technology.** 22 Apr 1978.

In Magnetic fusion energy quarterly report, January—March 1978.

This program is aimed at developing the technology required for carrying out the mirror reactor program. Much of this work applies to the national program and fusion in general; it covers the following areas: Superconducting magnet development; Neutral-beam program (including beam direct conversion and vacuum technology); Direct conversion: In addition to our study of the direct conversion associated with neutral beams, we have a continuing program to develop efficient direct recovery systems, which are required for reducing power losses from future mirror reactors. Materials program: We have a unique source of 14-MeV neutrons at the Rotating Target Neutron Source (RTNS-I), and LLL facility that is used to investigate the effects of fusion neutrons on materials of interest to reactor designers. Several key problems on tritium control and handling that must be solved for any large D-T fusion device are being investigated in the LLL tritium laboratory; emphasis is on cleanup of low tritium concentrations in reactor containment buildings and on the containment of tritium by using various low-permeability barriers and coatings to be applied to metal walls. The effects of neutrons on the properties of superconducting materials are being investigated using a unique apparatus in which superconducting properties are measured while the specimen is continuously maintained at liquid-helium temperature. Reactor design studies: Design studies of mirror reactors form a basis for evaluating mirror concepts and for guiding our long-range program. Present emphasis is on delineating features of reactors based on the tandem mirror reactor (TMR) concept, on a fission/fusion hybrid reactor based on the TMR, and on an engineering evaluation of a small reactor system based on field reversal. A special class of reactors that are small and candidates for construction in the next decade is being investigated in a program sponsored by the Electric Power Research Institute (EPRI).

2075 **Measurement of poloidal field distributions in Tokamaks by far-infrared polarimetry.** Kunz, W. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Physikalische Elektronik); Dodel, G. *Plasma Phys.;* **20**: No. 2, 171-174(Feb 1978).

A sufficiently precise measurement of small Faraday rotation angles in a Tokamak experiment should be possible. Besides the precision with which the Faraday rotation angles can be measured, the precision with which the poloidal field can finally be deduced from such measurements, depends on other factors such as the measuring precision of the electron density profile, the diameter of the probing beam and the deviation of the plasma from circular symmetry.

2076 **Charged E-layer.** Agafonov, A.V. (AN SSSR, Moscow. Fizicheskij Inst.). *Fiz. Plazmy;* **2**: No. 1, 57-62(1976). (In Russian).

A possibility is considered of the existence of a charged stationary state of an electron beam confined by an external homogeneous magnetic field with the reversal of the magnetic field within the limits of the beam (E-layer). Self-consistent solutions have been obtained both in the absence of electrostatic neutralization and with partial neutralization of the beam by ions. In the first case the magnetic field reversal is achieved by imposing a radial electrical field of a charged bar, placed along the axis of a circular electron beams. In the second case the beam charge is supposed to be partially neutralized by ions, their density being distributed over the beam cross section so that the coefficient of the charge neutralization is constant over the cross section. The conditions of the magnetic field reversal have been obtained for both cases.

POWER SUPPLIES, ENERGY STORAGE

2077 (PPPL—1406) **Poloidal field power supplies and their performance on the PDX machine.** Turitzin, N.M.; Oliaro, G.E. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Dec 1977. Contract EY-76-C-02-3073. 12p. (CONF-771029—220). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

The poloidal field of the PDX machine is a complex result of several individual fields produced by a number of coils distributed inside and outside the vacuum vessel. The time correlation, waveshapes and magnitude of currents in these coils require a variety of power supplies with different characteristics capable of satisfying the specific requirements of each field. This paper discusses these supplies and presents their performance on the PDX machine.

2078 (PPPL—1441, pp 3.7-3.9) **TFTR Ohmic Heating interrupters status report: April 28, 1978.** Bellomo, P. (Ebasco Services Inc., New York). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

Plasma initiation in the TFTR is accomplished by using Ohmic Heating (OH) Interrupters. The technical uncertainties associated with d-c current interruption have mandated the three-stage development program currently in progress.

2079 (PPPL—1441, pp 3.27-3.31) **HV Switch Tube Development Program status report: April 28, 1978.** Winje, R.A. (Princeton Univ., NJ). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The HV Switch Tube Development Program encompassed development contracts to both Eimac (Division of Varian) and RCA. Both companies were required to develop a design for the tube and to build and test two tubes. The development program began in April, 1976. Currently, both companies have built tubes; Eimac has built one and RCA has built two. As initially built, both tubes exhibited unstable operation; however, RCA has implemented design changes which stabilized the tube operation. Eimac has a design modification which they believe will produce stable operation when the change is implemented. Both tubes have been tested to a limited degree and no other abnormal characteristics have been observed.

2080 (SAND—78-0933C) **Operation of a 300 kV, 100 Hz, 30 kW average power pulser.** Buttram, M.T.; Rohwein, G.J. (Sandia Labs., Albuquerque, NM (USA)). 1978. Contract EY-76-C-04-0789. 6p. (CONF-780676—1). Dep. NTIS, MF A01.

From 13. pulse power modulator symposium; Buffalo, NY, USA (20 Jun 1978).

Portions of document are illegible.

Applications for efficient and reliable pulse power systems with long lifetimes ($>10^8$ shots) are foreseen for electron beam generators, heavy ion accelerators and lasers leading eventually to inertially confined fusion reactors. These systems will have to be capable of continuous operation for sustained periods without requiring major maintenance or repair. High operating efficiency will be required not only to minimize power consumption but also to avoid heat build up and consequent damage to components. The system described in this paper represents an initial effort to develop an efficient energy handling high voltage pulser to study the problems of long life components.

2081 **Crowbared load current having no ripple components with triggered vacuum switch.** Itagaki, K.; Kitamura, H. (Niigata Univ., Nagaoka (Japan). Faculty of Engineering). *Denki Gakkai Ronbunshi, B;* **97**: No. 7, 391-396(Jul 1977). (In Japanese).

In plasma experiments, crowbar circuits are employed as the countermeasure to the requirements to maintain quasi-steady direct current for the load and to prevent the polarity reverse of that current in the circuits having inductance as the load and capacitance as the source. Discussion was made on the method to suppress the ripple components in load current with a vacuum gap switch as the triggering switch of a circuit. First, the effect of circuit conditions on the half cycle interruption of high frequency discharge current by a vacuum gap switch and the changes of circuit conditions in relation to the current interruption of a triggering vacuum gap switch at crowbaring are described. Next, the experimental results and the considerations on them are presented. By interrupting the high frequency discharge current flowing through the triggering vacuum gap switch at the first zero-current point after crowbaring, the ripple components of load current thereafter were able to be made zero. It was also found that the vacuum gap switch used for

the experiment was able to interrupt the high frequency discharge current of 4 to 600 kHz at the first zero-current point (half cycle) within the range of 0.3 k.A/μs or less of the current gradient at interruption, 500 mC or less of the charge passing the gap, and 50 kV/μs of the rising of recovering voltage.

COOLING SYSTEMS

2082 (PPPL—1441, pp 2.53-2.57) **Vacuum vessel bellows cooling system test summary.** Reddan, W.; McAssey, E. (Ebasco Services, Inc., New York). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

To verify the adequacy of the proposed cooling system, two full-scale models of sections of a typical vacuum vessel bellows assembly were constructed. One model, constructed of wood, was dedicated to measuring the flow distribution within the bellows. The other model, consisting of two Inconel 625 convolutions which were heated electrically, was used to develop a heat transfer coefficient correlation for the flow range of interest (i.e., the "transition" zone). The test results indicated that the flow distribution is virtually uniform, the flow is stable, and the heat transfer coefficient can be as low as one-tenth of that given by the Dittus-Boelter correlation for fully developed turbulent flow. Based on these results, it was concluded that the proposed system (3600 cfm of gaseous nitrogen) can satisfy its design requirements, i.e., maintain the convolution temperatures below 150°C during "aggressive" discharge cleaning during which up to 60 kW is dissipated in the bellows assemblies.

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 2074

2083 (BNL—24561) **Development of negative ion based neutral beam systems in the USA.** Sluyters, T.; Prelec, K. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract EY-76-C-02-0016. 14p. (CONF-780695—1). Dep. NTIS, PC A02/MF A01.

From Neutral beam workshop; Abingdon, Oxon, UK (26 Jun 1978).

This paper discusses the progress of a double electron capture system under development at the Lawrence Laboratories, a direct extraction system based on negative ions from magnetron and Penning sources at Brookhaven National Laboratory and the negative ion production by laser irradiation of alkali hydride or deuteride targets pursued at TRW Inc.

2084 (LBL—7955) **Neutral beam injector research and development work in the USA.** Pyle, R.V.; Baker, W.R.; Barr, W.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1978. Contract W-7405-ENG-48. 11p. (CONF-780811—15). Dep. NTIS, PC A02/MF A01.

From 7. conference on plasma physics and control; Innsbruck, Austria (23 Aug 1978).

We describe neutral beam injector research and development at the Brookhaven National Laboratory, Lawrence Berkeley and Lawrence Livermore Laboratories, and Oak Ridge National Laboratory. All neutral beam systems for present and near-term applications are based on the acceleration and neutralization of positive ions. The research and development is carried out at LBL/LLL and ORNL. Present emphasis at LBL/LLL is on 80 to 120 kV systems for the mirror program and for the TFTR and D III tokamaks. Present emphasis at ORNL is on 40 to 80 kV systems for the PLT, ISX, and PDX, and 80 to 200 kV systems for LPTT and TNS tokamaks. Injectors for the future experiments and reactors may operate at energies of 200 keV or higher, especially for mirror machine applications, where positive-ion-based efficiencies will be very low, assuming no energy recovery. Research on negative-ion-based systems with potentially high efficiencies is carried out at BNL and at LBL/LLL and ORNL. The first demonstration of a high-power neutral beam based on negative ions is planned for 1980.

2085 (ORNL—5405, pp 129-144) **Plasma technology.** Haselton, H.H.; Barber, G.C.; Becraft, W.R. Aug 1978.

In Fusion Energy Division annual progress report for period ending 31 December 1977.

The Plasma Technology Section has the responsibility for: (1) development of multi-megawatt neutral beam systems for plasma heating, (2) development of techniques for fueling the plasma using high velocity pellets, and (3) development of vacuum pumps of large pumping speeds (approximately 10^6 to 10^8 liters/sec) compatible with neutral beam and fusion devices. Significant advances have been made in each of these areas.

2086 (PPPL—1441, pp 2.79-2.81) **TFTR tritium valve for pulsed gas feed, test results.** Rockensies, J.W. (Grumman Aerospace Corp., Bethpage, NY); Sue, B.; Walls, R. May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

This paper presents the results of a test program currently being conducted at the PPPL (Princeton Plasma Physics Lab) to evaluate the design of an engineering-model valve to be used for controlling pulsed-feed tritium injection scenarios into the TFTR (TOKAMAK) torus. The test program is designed to characterize the performance of the valve and determine throughput modulation and repeatability. Testing is being performed primarily with helium gas, but the capability to test with argon, deuterium, and hydrogen gases is available in order to provide an adequate data base to extrapolate to the tritium case. The TFTR proposed tritium feed system line configurations have also been simulated to evaluate dynamic effects of the pulsed feed.

2087 (PPPL—1441, pp 2.95-2.98) **Design and fabrication of an ion accelerator for TFTR-type neutral beam systems.** Paterson, J.A.; Duffy, T.J.; Haughian, J.M.; Biagi, L.A.; Yee, D.P. (Univ. of California, Berkeley). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The design of the prototype 120-keV, 65-A, 0.5-sec ion accelerator for TFTR-type beam systems is described. Details of the manufacture of the constituent parts are given along with descriptions of the major components of the accelerator. Included are the molybdenum grid structures, molybdenum shields, stainless steel hats and the epoxy insulator. Specific manufacturing problems are discussed along with the results of tests to determine the voltage holding capabilities of the assembly.

2088 (PPPL—1441, pp 2.99-2.103) **Neutral beam injection system for the Tokamak Fusion Test Reactor.** Pittenger, L.C.; Stone, R.R.; Valby, L.E.; Pedrotti, L.R. (Univ. of California, Livermore). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The paper presents an overview of the Lawrence Livermore Laboratory/Lawrence Berkeley Laboratory Neutral Beam Injection System design. Specifications for the machine and a general description of the total system are presented.

2089 (PPPL—1441, pp 3.15-3.25) **Neutral beam fast shutter valve assembly status report: April 28, 1978.** Wright, K.E. (Princeton Univ., NJ). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

A fast-acting shutter valve (conductance limiter) has to be developed for the TFTR. The basic purpose of the Fast Shutter Valve Assembly (FSVA) is to minimize the amount of tritium and other gas flow into the neutral beam lines from the torus (or vice versa) between normal operating pulses by limiting the neutral beam/torus connecting duct conductance to 10 1/sec during this period. The shutter will open in less than 150 msec, close in less than 150 msec, and remain open or closed for a variable time. The minimum clear aperture of the FSVA is 80 cm vertically and 70 cm horizontally. It is not required to withstand atmospheric pressure nor high bakeout temperatures.

2090 **Transition radiation from neutral beams of hydrogen isotopes.** DeRaad, L.L. Jr.; Erber, T. (Department of Physics, University of California, Los Angeles, California 90024). *Appl. Phys. Lett.;* **33**: No. 11, 908-909(1 Dec 1978).

Transition radiation can be emitted by neutral-charge structures, such as atoms, crossing the interface between dielectric media. Intensities in excess of 10^3 photons/sec, in the energy range 1—50 keV, may be obtained from high-power ($>$ or $\approx$100 kV, $>$ or $\approx$1 A) beams of neutral hydrogen isotopes incident on foils. This effect may have practical implications for constructing energy-sensitive monitors for intense neutral beams.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

REFER ALSO TO CITATION(S) 2074

2091 (MITNE—219) **Analysis of design strategies for mitigating the consequences of lithium fire within containment of controlled thermonuclear reactors.** Dube, D.A.; Kazimi, M.S. (Massachusetts

Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). Jul 1978. Contract EY-76-S-02-2431. 158p. Dep. NTIS, PC A08/MF A01.

A lithium combustion model (LITFIRE) was developed to describe the physical and chemical processes which occur during a hypothetical lithium spill and fire. The model was used to study the effectiveness of various design strategies for mitigating the consequences of lithium fire, using the UWMAK-III features as a reference design. Calculations show that without any special fire protection measures, the containment may reach pressures of up to 32 psig when one coolant loop is spilled inside the reactor building. Temperatures as high as 2000°F would also be experienced by some of the containment structures. These consequences were found to diminish greatly by the incorporation of a number of design strategies including initially subatmospheric containment pressures, enhanced structural surface heat removal capability, initially low oxygen concentrations, and active post-accident cooling of the containment gas. The EBTR modular design was found to limit the consequences of a lithium spill, and hence offers a potential safety advantage. Calculations of the maximum flame temperature resulting from lithium fire indicate that none of the radioactive first wall materials under consideration would vaporize, and only a few could possibly melt.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 2074

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 1172, 1954, 1961, 2080

2092 (LA-UR—78-1457) **Computer programs for capital cost estimation, lifetime economic performance simulation, and computation of cost indexes for laser fusion and other advanced technology facilities.** Pendergrass, J.H. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 13p. (CONF-780508—63). Dep. NTIS, PC A02/MF A01.

From 3. meeting on the technology of controlled thermonuclear fusion; Santa Fe, NM, USA (9 May 1978).

Three FORTRAN programs, CAPITAL, VENTURE, and INDEXER, have been developed to automate computations used in assessing the economic viability of proposed or conceptual laser fusion and other advanced-technology facilities, as well as conventional projects. The types of calculations performed by these programs are, respectively, capital cost estimation, lifetime economic performance simulation, and computation of cost indexes. The codes permit these three topics to be addressed with considerable sophistication commensurate with user requirements and available data.

2093 (LA-UR—78-1627) **Inertial confinement fusion reactor cavity phenomena.** Bohachevsky, I.O.; Hafer, J.F.; Devaney, J.J.; Pendergrass, J.H. (Los Alamos Scientific Lab., NM (USA)). 1978. Contract W-7405-ENG-36. 12p. (CONF-780508—61). Dep. NTIS, PC A02/MF A01.

From 3. meeting on the technology of controlled thermonuclear fusion; Santa Fe, NM, USA (9 May 1978).

Cavity phenomena in Inertial Confinement Fusion (ICF) are created by the interaction of energy released by the fuel pellet microexplosion with the medium inside the reactor cavity. The ambient state of the medium in ICF reactor cavities is restricted primarily by its effects on laser beam propagation and on the fuel pellet trajectory. Therefore, a relatively wide choice of ambient conditions can be exploited to gain first-wall protection and advantages in energy extraction. Depending on the choice of ambient cavity conditions and on fuel pellet design, a variety of physical phenomena may develop and dominate the ICF reactor cavity design. Because of the cavity phenomena, the forms of energy released by the fuel-pellet microexplosion are modified before reaching the first wall, thus giving rise to different cavity design problems. The types of cavity phenomena encountered in the conceptual design of ICF reactors are examined, the approaches available for their modeling and analysis are discussed, and some results are presented. Most phenomena are sufficiently well understood to permit valid engineering assessments of the proposed ICF reactor concepts.

2094 (TID—28658) **Filamentation instability of ion beams focussed in pellet fusion reactors.** Hubbard, R.F.; Tidman, D.A. (Maryland Univ., College Park (USA). Inst. for Physical Science and Technology). Jun 1978. Contract EY-76-S-05-5000. 18p. Dep. NTIS, PC A02/MF A01.

The growth of current filamentation instability is calculated for intense multi-GeV heavy ion beams focussed across a target chamber onto a fusion pellet. Conditions for which this instability growth can be kept small are given.

2095 (TID—28659) **Propagation of high current particle beams through gases.** Spicer, D.S.; Tidman, D.A.; Hubbard, R.F. (Maryland Univ., College Park (USA). Inst. for Physical Science and Technology). 1977. Contract EY-76-S-05-5000. 26p. Dep. NTIS, PC A02/MF A01.

A model for the propagation of high current beams of ions or electrons through an initially neutral or partially ionized gas is described. Numerical results are given for the transport and focusing of intense ion beams onto a pellet at the center of the target chamber of a pellet fusion reactor.

2096 (UCRL—13874) **Intramural orders 5879509 (1971-1974), 6224305 (1974-1975), 9037305 (1975-1976), and 3233503 (1976-1977).** DeGroot, J. (California Univ., Davis (USA)). 7 Mar 1978. Contract W-7405-ENG-48. 32p. Dep. NTIS, PC A03/MF A01.

In the experimental effort, microwaves excite parametric instabilities and/or resonantly drive plasma waves in geometries as close to laser fusion geometries as possible. The resultant absorption, heated electron distributions, and energy transport are measured. The theoretical and computational effort is directed toward analysis of ways of controlling and reducing reflection, the number of very high energy electrons, and predicting the reduction of energy transport due to instabilities.

2097 (Y—2125) **Fabrication of off-axis parabolic mirrors.** Bezik, M.J.; Gerth, H.L.; Sladky, R.E.; Washington, C.A. (Oak Ridge Y-12 Plant, TN (USA)). Aug 1978. Contract W-7405-ENG-26. 39p. Dep. NTIS, PC A03/MF A01.

The report describes the fabrication process, including metal preparation, copper electroplating, single-crystal-diamond turning, optical inspection, and polishing, used to manufacture the focusing mirrors for the 10-kJ laser fusion experiment being conducted by the Los Alamos Scientific Laboratory. Fabrication of these mirrors by the techniques described resulted in diffraction-limited optics at a 10.6 μm wavelength.

2098 (Y/DA—7747) **LASL Laser Mirror Program. Excerpts from Y-12 Development Division technical progress reports for period ending March 1, 1978.** Thompson, C.H. (comp.). (Oak Ridge Y-12 Plant, TN (USA)). 11 Jul 1978. Contract W-7405-ENG-26. 39p. Dep. NTIS, PC A03/MF A01.

Separate abstracts were prepared for each of the 5 included sections. (MOW)

2099 (Y/DA—7747, pp 3-9) **Evaluating a bright acid copper electroplating bath.** Waldrop, F.B.; Bezik, M.J.; Waldrop, R.C. 11 Jul 1978.

In LASL Laser Mirror Program. Excerpts from Y-12 Development Division technical progress reports for period ending March 1, 1978.

Bright acid copper electroplating baths (i.e., acid copper sulfate baths with organic brighteners) are being studied to provide additional information concerning their behavior in extended use. It has been found that the chloride ion content of the baths has a significant effect on the character of the electrodeposit. Anode polarization is a problem and methods of operating without an anode bag, which is believed to be primarily responsible for the polarization, are being explored. The nature of the electrodeposits varies in an erratic manner, and it is believed that this inconsistency may be due to the effects of anodic oxidation of organics in the bath. Anodic oxidation of many organics could be expected to occur at the high potential drop at the anode, due to polarization.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 2085

2100 (CONF-780508—59) **Damage analysis and fundamental studies program. Paper 78-97.** Doran, D.G.; Reuther, T.C.; Robinson, M.T. (Hanford Engineering Development Lab., Richland, WA (USA); Department of Energy, Washington, DC (USA); Oak Ridge National Lab., TN (USA)). 1978. Contract W-7405-ENG-26. 13p. Dep. NTIS, PC A02/MF A01.

From 3. meeting on the technology of controlled thermonuclear fusion; Santa Fe, NM, USA (9 May 1978).

The Damage Analysis and Fundamental Studies (DAFS) Task Group has been formed by the Office of Fusion Energy to develop procedures for applying data obtained in various irradiation test facilities to projected fusion environments. A long-range program plan has been prepared and implementation has begun. The plan and technical status are briefly described.

2101 (DOE/ET—0032/1) **Fusion reactor materials program plan. Section 1. Alloy development for irradiation performance.** (Department of Energy, Washington, DC (USA)). Jul 1978. 101p. Dep. NTIS, PC A06/MF A01.

This report outlines the following: (1) program goals, (2) alloy development for irradiation performance task group, (3) prob-

lem definition and analysis, (4) analysis and evaluation, (5) mechanical behavior, (6) in-reactor deformation, (7) program strategy and major milestones, and (8) task descriptions. (MOW)

2102 (DOE/ET—0032/2) **Fusion reactor materials program plan. Section 2. Damage analysis and fundamental studies.** (Department of Energy, Washington, DC (USA)). Jul 1978. 125p. Dep. NTIS, PC A06/MF A01.

The scope of this program includes: (1) Development of procedures for characterizing neutron environments of test facilities and fusion reactors, (2) Theoretical and experimental investigations of the influence of irradiation environment on damage production, damage microstructure evolution, and mechanical and physical property changes, (3) Identification and, where appropriate, development of essential nuclear and materials data, and (4) Development of a methodology, based on damage mechanisms, for correlating the mechanical behavior of materials exposed to diverse test environments and projecting this behavior to magnetic fusion reactor (MFR) environments. Some major problem areas are addressed.

2103 (ORNL—5405, pp 199-212) **Materials.** Bell, J.T.; Bishop, B.L.; Bloom, E.E. Aug 1978.

In Fusion Energy Division annual progess report for period ending 31 December 1977.

The measured effects of irradiation on the engineering properties of candidate alloys are evaluated to serve three goals: (1) to set the direction of further experimental investigation, (2) to identify promising directions for alloy improvement by control of chemistry or microstructure, and (3) to identify limitations that material properties impose on fusion power systems. Examination of the effect of modifying type 316 stainless steel by the addition of small amounts of titanium shows that this is a promising approach to be pursued in the search for alloys that meet the demands of fusion power systems. The resistivity of several commercial organic insulators decreased promptly by a factor of approximately 10^3 under intense gamma ray irradiation, but the insulators showed little further change during irradiation at 4.8°K to a dose of 2×10^8 R. Postirradiation testing of electrical and mechanical properties at 300°K showed little change over preirradiation values.

2104 (ORNL/TM—6486) **Neutron-photon multigroup cross sections for neutron energies <60 MeV.** Alsmiller, R.G. Jr.; Barish, J. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 38p. Dep. NTIS, PC A02/MF A01.

Multigroup cross sections (47 n-groups, 21 γ-groups) in ANISN format for neutron energies from thermal to 60 MeV and for the elements H, ^{10}B, ^{11}B, C, O, Si, Ca, Cr, Fe, and Ni are described. A P_5-Legendre expansion is used at energies equal to or greater than 14.9 MeV and a P_3-Legendre expansion is used at energies equal to or less than 14.9 MeV. Calculated results of the dose equivalent vs. depth in the shield from a point isotropic source at the center of a spherical shell (366 cm thick) heavy-concrete (density = 3.6 g cm^{-3}) shield are presented. The energy distribution of the source neutrons is approximately that from a Li(D,n) neutron radiation damage facility.

2105 (ORNL/TM—6487) **Design calculations for a 14-MeV neutron collimator.** Lillie, R.A.; Alsmiller, R.G. Jr.; Mihalczo, J.T. (Oak Ridge National Lab., TN (USA)). Aug 1978. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

A number of SS-316 right circular cylindrical shells of varying lengths have been analyzed using two-dimensional discrete ordinates transport methods together with first and last flight particle estimators to aid in the design of neutron collimators for the Tokamak Fusion Test Reactor. In the TFTR the 14-MeV neutron source has a very large spatial extent and the collimators must be designed to allow spectral measurements that refer to only a small spatial region of this extended source. The analysis identifies the 14-MeV neutrons from scattering in the SS-316 immediately adjacent to the collimator opening as the dominant contributor to detector background. Collimator lengths greater than 0.60 m were found sufficient to attenuate uncollided background neutrons for reasonable source-detector distances. The lower energy (less than 13.8 MeV) neutron background and gamma background were not found to be significant.

2106 (PPPL—1396) **In-torus zirconium--aluminum getter pumping for beam-driven tokamaks.** Bromberg, L.; Jassby, D.L. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Nov 1977. Contract EY-76-C-02-3073. 8p. (CONF-771029—219). Dep. NTIS, PC A02/MF A01.

From 7. symposium on fusion research project; Knoxville, TN, USA (25 Oct 1977).

This report describes the design of a steady-state high-thoughput exhaust system for a neutral beam-driven and beam-fueled tokamak plasma with 1000 A-equiv. injected current. An array of Zr-Al getter assemblies fills the entire region below the 1.9-m diameter plasma, in the same vacuum chamber. The Zr-Al getter is bonded to 1-cm-wide copper fins brazed to stainless steel tubes cooled by high-pressure helium, which maintains the operating temperature at 300°C for a thermal power loading up to 1 MW/m^2. Six stacked tubes form a 0.48-m-tall collecting module with a capture efficiency of 70% for D°. Nearly uniform pumping over the 24-module 900-m^2 collection area insures a getter saturation time of 12 hr, with a down-time of 0.5 hr required for regeneration at 700°C, obtained by flowing hot helium. The getter lifetime, which is determined by sorption of impurity atoms, is at least several months.

2107 (PPPL—1441, pp 2.1-2.3) **Tokamak Fusion Test Reactor vacuum vessel: development of electrical resistance bellows.** Wittko, J. (Grumman Aerospace Corp., Bethpage, NY); Kountouras, N.V. May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

This paper describes the design, evolution, fabrication, and installation of the development electrical resistance bellows for the vacuum vessel of the TFTR (TOKAMAK Fusion Test Reactor).

2108 (PPPL—1441, pp 2.5-2.19) **Design study for TFTR vacuum vessel protective plates.** Fixler, S.Z.; Powell, E. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

This paper presents the results of a design study conducted on the Tokamak Fusion Test Reactor (TFTR) Vacuum Vessel Protective Plates (VVPP). Several design concepts were investigated, with the design variables including single- and double-wall configurations, several tile mounting options, and several material candidates. The mechanical, thermostructural, and material aspects of the various designs are discussed. The design approach, design requirements, design loads, thermal responses, thermal stress distributions, and remote handling considerations are included.

2109 (PPPL—1441, pp 2.39-2.43) **Remotely operable vacuum seals.** Frank, A.M. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The development of large, non-round, bakeable, high-vacuum, remotely-operable seals breaks down into three separate tasks. The first was to provide a system capable of remotely sealing and breaking a vacuum joint. The second was to choose between mechanical and welded joints. The third, mechanical joints having been chosen, is to resolve the problems associated with extending the state-of-the-art from round seals to large non-round seals. The factors affecting the decisions made are presented and the follow-on plan is discussed.

2110 (PPPL—1441, pp 2.45-2.48) **Remote leak detection for the TFTR.** Walthers, C.R. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The planned design for the TFTR (TOKAMAK Fusion Test Reactor) remote leak detection system consists of a central console which controls the application of tracer gas to possible leak areas. Seals are tested by admitting tracer gas to machined cavities on the atmospheric side of the seal. The tracer gas is brought to the seal cavity by $^1/_8$-inch diameter tubes which connect to local tracer gas/vacuum manifolds located outside the protective radiation shielding. Vacuum shell walls and welds are checked by flowing tracer gas through annular heating/cooling passages. The detector will be either an MSLD (mass spectrometer leak detector) or an RGA (residual gas analyzer), the location of which is not finalized. Feasibility tests performed and planned include response and sensitivity measurements of possible tubing/detector configurations with several tracer gases.

2111 (PPPL—1441, pp 2.49-2.52) **Removability of oil contamination from TFTR torus walls by bakeout and gas purging.** Chang, J.; Bondurant, R.; Maciulaitis, A.; Stauber, M. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

To investigate the possibility of cleanup after an accidental backstreaming of TMP oil (Winsor L-245X) into the TFTR torus, the removability of oil contaminant from stainless steel surfaces was tested experimentally using a prescribed bakeout/purging procedure

under a simulated TFTR radiation environment. At low contamination levels, the bakeout/purging operations resulted in residues of 0.5 percent and 2.0 percent for unirradiated and irradiated oil, respectively. At higher contamination levels, the bakeout/purging process was found ineffective. In all cases, exposure to radiation resulted in larger amounts of residue. Variations in N_2 purging pressure and geometry had only minor effects on removability. These results, combined with those obtained from differential gassing rate measurements on the same surfaces, yielded some additional conclusions: (1) The possibility exists that most of the observed residue tends to accumulate along the gaps near the gaskets (the effects of nooks and crannies), and (2) irradiation of oil generally results in larger amounts of oil residue, with these residues exhibiting much lower gassing rates.

2112 (PPPL—1441, pp 2.59-2.62) **Development of large insulator rings for the Tokamak Fusion Test Reactor.** Brown, T.; Tobin, A. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

This paper discusses research and development leading to the manufacture of large ceramic insulator rings for the TFTR (TOKAMAK Fusion Test Reactor). Material applications, fabrication approach and testing activities are highlighted.

2113 (PPPL—1441, pp 2.63-2.69) **Plasma position control for TFTR using modern control theory.** Gran, R.; Rossi, M.J.; Sobieajski, F. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

A control system design for the Tokamak Fusion Test Reactor (TFTR) has been developed using linear optimal control techniques. The features of this design that make it distinct from past control system designs are given.

2114 (PPPL—1441, pp 2.71-2.78) **Electrical fault location.** Neumeyer, C. (Ebasco Services, Inc., New York); Wertheim, M. May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The effort described herein fell naturally into two categories: (1) System Ground Faults, and (2) Turn-to-Turn Faults within a coil. Fault detection and location was to be studied both for the Toroidal Field (TF) Coil System and the two Poloidal Field (PF) Coil Systems: Equilibrium Field (EF), and Ohmic Heating (OH). The studies proved fruitful in demonstrating that ground faults could be detected for both sets of systems, and instrumentation was therefore recommended. The TF Coil System turn-to-turn fault study also showed a high probability that turn-to-turn faults could be detected and isolated to a particular coil, and that protective action could be initiated rapidly enough to reduce the consequences of the fault. The PF Coil Systems turn-to-turn fault studies are not far enough along to make a report. This paper does not concern itself with details of the analytical studies which provided the data on which the instrumentation systems are based. Rather, it describes these systems and their operation.

2115 (PPPL—1441, pp 2.83-2.88) **In-vessel maintenance remote manipulator system.** Jimenez, E. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The radiation environment within the Tokamak Fusion Test Reactor (TFTR) vacuum vessel necessitates the development of a Remote Manipulator System (RMS) to perform required periodic inspection and maintenance tasks. The RMS must be able to perform dexterous operations and handle loads that exceed human capabilities. The limited size of the access ports on the TFTR vacuum vessel and the performance profile, defined by the various handling requirements, present unique design constraints. The design approach and formulation of a RMS configuration which satisfies TFTR requirements is presented herein.

2116 (PPPL—1441, pp 2.89-2.93) **Vacuum system transient simulator and its application to TFTR.** Sredniawski, J. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

The vacuum system transient simulator (VSTS) models transient gas transport throughout complex networks of ducts, valves, traps, vacuum pumps, and other related vacuum system components. VSTS is capable of treating gas models of up to 10 species, for all flow regimes from pure molecular to continuum. Viscous interactions between species are considered as well as non-uniform temperature of a system. Although this program was specifically developed for use on the Tokamak Fusion Test Reactor (TFTR) project at Princeton, it is a generalized tool capable of handling a broad range of vacuum system problems. During the TFTR engineering design phase, VSTS has been used in many applications. Two applications selected for presentation are: (1) torus vacuum pumping system performance between 400 Ci tritium pulses and (2) tritium backstreaming to neutral beams during pulses.

2117 (PPPL—1441, pp 3.5-3.6) **Remotely operable vacuum seals status report: April 28, 1978.** Frank, A. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

Work has progressed on the design, fabrication, and test of the mechanical portions of the remotely operable vacuum seal program. Successful testing of the 12 x 18 in. obround specimen utilizing a modified "Conflat" seal has been completed. A 7 x 20 in. United Technologies specimen and a small, round "Gamah" coupling have also successfully completed multiple bakeouts without leaking. Full-size specimens are presently being fabricated for testing the modified "Conflat" seal, the United Technologies seal, and the Helicoflex seal.

2118 (PPPL—1441, pp 3.11-3.13) **Remote welder/cutter status report: April 28, 1978.** Dietz, L. (Grumman Aerospace Corp., Bethpage, NY). May 1978.

From Information meeting; Princeton, NJ, USA (9 May 1978).

In Highlights of research and development activities for the Tokamak Fusion Test Reactor Project.

TFTR maintenance needs require the design and development of a Remote Welder/Cutter Mechanism capable of remotely and automatically severing the vacuum vessel shell at designated areas and subsequently welding a replacement segment in place. This device is presently being designed.

GENERAL AND MISCELLANEOUS

2119 (ORNL/TM—6317) **Remarks delivered at the awards ceremony.** Brumberger, H.; Hendricks, R.W. (eds.). (Oak Ridge National Lab., TN (USA)). Jun 1978. Contract W-7405-ENG-26. 36p. Dep. NTIS, PC A03/MF A01.

For almost four decades, the distinguished trio of professors, W. W. Beeman, A. Guinier, and O. Kratky, have provided leadership of the field of small-angle scattering through both their teaching and their personal research. Collectively, they have authored or coauthored over 400 scientific articles and reviews, several books, and have been associated with over 140 graduate and postdoctoral students. It was thus appropriate that each should be honored for his outstanding contributions to the field at the Fourth International Conference on Small-Angle Scattering which was held in Gatlinburg, Tennessee, in October 1977. The Board of Directors of the Special Interest Group on Small-Angle Scattering of the American Crystallographic Association in conjunction with the Conference Organizing Committee, arranged a special awards ceremony during which each honoree presented his personal reminiscences of the development of small-angle scattering in his own laboratory. This report is a record of this event.

MANAGEMENT

REFER ALSO TO CITATION(S) 814

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 42, 267, 1323

2120 (ANL-AMD-TM—324) **Testing unconstrained optimization software.** More, J.J.; Garbow, B.S.; Hillstrom, K.E. (Argonne National Lab., IL (USA)). Jul 1978. Contract W-31-109-ENG-38. 96p. Dep. NTIS, MF A01.

Portions of document are illegible.

Much of the testing of optimization software is inadequate because the number of test functions is small or the starting points are close to the solution. In addition, there has been too much emphasis on measuring the efficiency of the software and not enough on testing reliability and robustness. To address this need, a relatively large but easy-to-use collection of test functions was produced and guidelines for testing the reliability and robustness of unconstrained optimization software were designed. 9 tables.

2121 (DOE/ER—0007) **Report of the Subpanel on Computing Needs of the High Energy Physics Advisory Panel to the U.S. Department of Energy.** (High Energy Physics Advisory Panel (USA). Subpanel on Computing Needs). Apr 1978. 32p. Dep. NTIS, PC A03/MF A01.

The service and budgetary requirements of computers including off-line data processing and analysis are reported for Fermi National Accelerator Laboratory, Stanford Linear Accelerator Center, and Lawrence Berkeley Laboratory. (JFP)

2122 (IS—4460) **Proportion estimation and classification of mixed pixels in multispectral data.** Crouse, K.R.; Lambert, R.J.; Sposito, V.A. (Ames Lab., IA (USA)). Jul 1978. Contract W-7405-ENG-82. 124p. Dep. NTIS, PC A06/MF A01.

Data from the LANDSAT satellite are being extensively utilized in a wide range of applications in agriculture, geology, hydrology, environmental monitoring, and other fields. The multispectral scanner aboard the satellite records the electromagnetic radiation at several wavelengths emanating from the objects within its field of view. Different materials reflect radiation differently at various wavelengths, enabling one to distinguish objects on the basis of their spectral responses recorded at several wavelengths. Whenever the objects being viewed by a multispectral scanner are not large relative to the size of a resolution element, a significant portion of the data recorded will consist of a mixture of the responses of two or more objects. To determine the percent of a region covered by each type of object accurately, it becomes necessary to estimate the proportions of objects within a resolution element. Two types of proportion estimators are examined and compared: an estimator based on maximum likelihood and a shortcut method. Both are tested under point-by-point estimation and estimation with data averaging. The assumption that the class covariance matrices are equal and the assumption that the classes follow normal distributions are also examined. Covariance matrices extracted from LANDSAT data are subjected to a likelihood-ratio test for equality, and the effect of assuming equal covariance matrices when the actual covariances are unequal to various degrees is assessed. A classification procedure based on the L_1 norm is presented as an alternative to the usual least-squares procedure when normality does not hold. Tests are run to compare the accuracy of the two classification procedures using both normal and nonnormal data. 26 figures, 13 tables.

2123 (LA—6943-H) **Computing at LASL in the 1940s and 1950s.** Lazarus, R.B.; Voorhees, E.A.; Wells, M.B.; Worlton, W.J. (Los Alamos Scientific Lab., NM (USA)). May 1978. Contract W-7405-ENG-36. 31p. Dep. NTIS, MF A01.

Portions of document are illegible.

This report was developed from four talks presented at the Pioneer Day session of the 1977 National Computer Conference. These talks surveyed the development of electronic computing at the Los Alamos Scientific Laboratory during the 1940s and 1950s. 31 figures.

2124 (LA—7353-MS) **Terms of an arithmetic sequence prime to M.** Everett, C.J. (Los Alamos Scientific Lab., NM (USA)). Aug 1978. Contract W-7405-ENG-36. 10p. Dep. NTIS, PC A10/MF A01.

The structure of the set, M, of terms of an arithmetic sequence prime to an integer, m, is completely determined, and its relation to the theorem of Dirichlet on primes in such a sequence is discussed. The geometric subsequences of an arithmetic sequence are also completely characterized.

2125 (LA—7361-MS) **Study of data communications at the Los Alamos Scientific Laboratory, 1977.** Lewis, R.E.; Gore, R.A. (Los Alamos Scientific Lab., NM (USA)). Jun 1978. Contract W-7405-ENG-36. 24p. Dep. NTIS, PC A02/MF A01.

The rapid growth in the use of local and remote computing at the Los Alamos Scientific Laboratory (LASL) prompted an investigation of the need for more data-commmunications facilities. This report describes the available technology for such facilities, the results of a survey of the data-communications activities and needs of selected LASL organizations, and a discussion of the need for a LASL wide-bandwidth data-communications utility.

2126 (LA—7389-MS) **LINPACK working note No. 11: some LINPACK timings on the CRAY-1.** Dongarra, J.J. (Los Alamos Scientific Lab., NM (USA)). Aug 1978. Contract W-7405-ENG-36. 21p. Dep. NTIS, PC A02/MF A01.

This report compares the Los Alamos Scientific Laboratory (LASL) compilers and FORTRAN tools used in running programs on the CRAY-1 computer. A sample of linear equation routines from the LINPACK collection were tried with these compilers and tools to determine what aids give the fastest execution speed for FORTRAN codes run on the CRAY-1. 4 figures, 4 tables.

2127 (NUREG/CR—0293) **Comparison of shortest path algorithms applied to sparse graphs.** Hulme, B.L.; Wisniewski, J.A. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 48p. (SAND—78-1411). Dep. NTIS, PC A03/MF A01.

Three methods are compared for finding shortest paths from one node to all other nodes in sparse, nonnegatively weighted, directed graphs. Dijkstra's method with a heap sort, Ford's method with a sequence list, and Yen's method are considered the best representatives of certain classes of methods for this problem. They have essentially the same storage requirements and are compared on the basis of algorithm execution time for a test set of randomly generated problems. For directed graphs that are sufficiently sparse, Ford's method with a sequence list is the fastest of the three methods. A different version of Ford's algorithm is proposed for use in the special case of undirected sparse graphs in order to make efficient use of the symmetry of the distance matrix.

2128 (ORNL/CSD/TM—59) **CONTUR: a subroutine to draw contour lines for randomly located data.** Patterson, M.R. (Union Carbide Corp., Oak Ridge, TN (USA). Computer Sciences Div.). Jul 1978. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

A set of routines collectively called CONTUR was written to draw contour lines for data given at arbitrary positions in a plane. Rather than requiring that the interconnections among the data points be known, the CONTUR routine connects the points with triangles. The path of a given contour can be traced from knowing the connectivity of the triangles that are generated. Smoothed parametric spline routines are used to draw a smooth contour line. The boundary lines connecting points on the periphery or excluding an inner region can be defined, if necessary. 7 figures.

2129 (ORNL/CSD/TM—66) **Universal plotting facility.** Burris, R.D. (Union Carbide Corp., Oak Ridge, TN (USA). Computer Sciences Div.). Aug 1978. Contract W-7405-ENG-26. 56p. Dep. NTIS, PC A04/MF A01.

A plotting system was implemented which separates the user interface and the data manipulation and conversion phases of conventional plotting software. Implementation of this system permits the plotting of any supported data format upon any supported device while requiring the user to learn only one command. The system features powerful error detecting and correcting features, extensive defaulting capability, and simple maintenance. 1 figure.

2130 (SAND—77-1666) **Application of maximum—minimum distance circuits on hypercubes (to pseudo-color graphics displays).** Simmons, G.J. (Sandia Labs., Albuquerque, NM (USA)). Aug 1978. Contract EY-76-C-04-0789. 22p. Dep. NTIS, PC A02/MF A01.

The related questions of finding Hamilton circuits in the n-dimensional cube with d points on an edge which maximize the minimum "taxicab" distance between successive vertices and/or which maximize the sum of such distances over the entire circuit is investigated. A "good" bound for the first quantity and an achievable limit for the second are developed, and several optimal constructions, found. Both of these circuits are solutions to one formulation of the problem of designing pseudo-color graphics displays in which minimal grey scale differences become maximal color differences. 5 figures, 3 tables.

2131 (SAND—78-0522) **Modifications of SUPORT, a linear boundary value problem solver. Part III. Orthonormalization improvements.** Lord, M.E.; Watts, H.A. (Sandia Labs., Albuquerque, NM (USA); Texas Univ., Arlington (USA)). May 1978. Contract EY-76-C-04-0789. 28p. Dep. NTIS, PC A03/MF A01.

Some improvements in the orthonormalization process for the SUPORT code, which solves linear two-point boundary-value problems, are discussed. Various alternatives for a linear dependence test are also considered. A scheme which reduces the frequency of the linear dependence test is incorporated, and numerical results are shown for several sample problems. 5 tables.

2132 (SAND—78-0725) **Array multiplier for twos-complement binary numbers.** Simpson, J.E. (Sandia Labs., Albuquerque, NM (USA)). Jul 1978. Contract EY-76-C-04-0789. 12p. Dep. NTIS, PC A02/MF A01.

The Base and Installation Security Systems Program Office (BISSPO) is funding a project at Sandia Laboratories to implement transducer signal processing algorithms in microprocessor-based systems. This report describes a fast, low-power, binary multiplier

which was developed to support the microprocessor-based signal processors. 2 figures.

2133 (SAND—78-1244) **Efficient integration processes for solving boundary value problems.** Watts, H.A. (Sandia Labs., Albuquerque, NM (USA)). Jun 1978. Contract EY-76-C-04-0789. 26p. Dep. NTIS, PC A03/MF A01.

The efficient solution of two-point boundary-value problems by initial-value methods is discussed. Non-linear problems are to be solved by quasilinearization which results in a sequence of linear problems. The technique of interest for solving the linear two-point boundary-value problem is to combine reduced superposition with an orthonormalization process. Such an approach requires integration of a number of independent solutions, defined as initial-value problems. Because linear differential equations are being solved, a substantial savings in the cost of evaluating the derivatives can be achieved. These possibilities are examined, along with numerical integration schemes which are particularly efficient in such circumstances. 9 tables.

2134 (TREE—1138(Rev.1)) **MOCARS: a Monte Carlo code for determining distribution and simulation limits and ranking system components by importance.** Matthews, S.D.; Poloski, J.P. (Idaho National Engineering Lab., Idaho Falls (USA)). Aug 1978. Contract EY-76-C-07-1570. 117p. Dep. NTIS, MF A01.

Portions of document are illegible.

MOCARS is a computer program designed for use on the Idaho National Engineering Laboratory (INEL) CDC CYBER 76-173 computer system that uses Monte Carlo techniques to determine the distribution and simulation limits for a function. In use, the MOCARS program randomly samples data from any of the 12 different user-specified probability distributions and either evaluates a user-specified function or cut set system unavailability using the sample data. After data ordering, the values at various quantities and associated confidence bounds are calculated for output. If the cut set unavailability function is evaluated, MOCARS can determine the importance ranking for components in the unavailability calculation. Frequency and cumulative distribution histograms from the sample data are also available for output on microfilm. 39 figures, 4 tables.

2135 **Mixed-hybrid finite element approximations of second-order elliptic boundary value problems. Part II. Weak-hybrid methods.** Babuska, I. (Univ. of Maryland, College Park); Oden, J.T.; Lee, J.K. *Comput. Methods Appl. Mech. Eng.;* **14**: No. 1, 1-22(Apr 1978).

A new class of hybrid finite element methods is presented for the numerical analysis of second-order elliptic boundary value problems. The methods are characterized by the use of particular solutions of the differential equation being solved, in contrast to conventional hybrid methods in which polynomial approximations are used. As a model problem the Dirichlet problem for Laplace's equation is studied. A priori error estimates are derived and the results of numerical experiments are presented.

2136 **Why does a mass on a spring sometimes misbehave.** Olsson, M.G. (Univ. of Wisconsin, Madison). *Am. J. Phys.;* **44**: No. 12, 1211-1212(Dec 1976).

Autoparametric resonance of a mass on a spring was investigated. It is shown that when a spring is loaded so that it stretches to four-thirds of its original rest length, the spring frequency will be double the pendulum frequency and it will not be possible to excite a pure verticcal spring oscillation. (GHT)

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 219, 817, 1361

2137 (TID—28652) **Establishment of a Registry Information Center for Taxonomic Resources and Services. Third quarter progress report.** (Association of Systematics Collections Information Center, Lawrence, KS (USA)). 25 May 1978. Contract EY-76-C-02-2987. 34p. Dep. NTIS, MF A01.

Portions of document are illegible.

Progress is reported on the establishment of a registry information center for taxonomic resources and services. Objectives of the project include promotion, file maintenance and updating, informational services, system development, and protocol for assessing specimen-related information. (HLW)

2138 (ORNL-tr—4573) **PCM techniques aid in storing analog data: an exact magnetic-tape storage method for analog measurement signals.** Glockmann, H.P. Translated by D. Jacobson from *Elektron. Praxis;* **8**: No. 7-8, 4p.(1973). 14p. Dep. NTIS, PC A02/MF A01.

Modern measurement practice, requiring ever greater accuracy and increasing numbers of data channels, places excessive demands on the performance capabilities of traditional FM methods for recording and storing signals which change continuously over time. In contrast, the PCM method (pulse code modulation) can meet these demands. Since this method is relatively expensive in terms of the circuitry involved, however, the construction of more economical and operationally dependable PCM analog magnetic tape storage units was made possible only with the favorable market development of integrated semiconductor components. 3 figures, 1 table.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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Insulation meeting: Department of Energy. Transcript of proceedings, 4:902 (CONF-771256—)

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Feasibility study of using a coal/water/oil emulsion as a clean liquid fuel: Phase 2. Interim report, January—March 1977, 4:165 (FE—2437-3)
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Aerospace Corp., El Segundo, CA (USA)
Impedance measurements on sealed lead—acid cells, 4:811 (ATR—78(8114)-1)
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Airco Cryogenics, Irvine, CA (USA)
Investigation of high velocity wedge separator for particle removal in coal gasification plants. Phase I report, 4:20 (ACD—38391-4)

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Research and development of stabilized multifilamentary Nb_3 Sn superconductors. Technical report for the period, 12 September 1976 through 30 September 1977, 4:1041 (UCRL—13881)

AiResearch Mfg. Co., Torrance, CA (USA)
Design, fabrication, and testing of a full-scale breadboard nitrogen generator for fuel tank inerting application. Final report, 4:976 (FAA-RD—77-147)

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Large-scale optical mapping of the ionosphere. Environmental research papers, 4:1624 (AD-A—051122)
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Studies of physical and chemical characteristics of rocks in geothermal fields, 4:524 (NP—23254)

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Low temperature nuclear heat, 4:670 (CONF-770893—)

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Electronic contribution to anomalous phonon dispersion in Zr, 4:1037 (IS-M—136)
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Proportion estimation and classification of mixed pixels in multispectral data, 4:2122 (IS—4460)
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Application of air ejectors to the performance improvement and cost reduction of compressed air storage power plants, 4:806 (CONF-780599—1)
Constraints on coal utilization due to air quality requirements, 4:125 (ANL/IAPE/TM—78-5)
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Empirical investigation of the factors affecting socioeconomic impacts from energy development, 4:124 (ANL/IAPE/TM—78-3)
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Transport of ions with multiple charge states in neoclassical theory, 4:1979 (CONF-780475—1)
UK/USA core restraint exchange study NUBOW-3D results, 4:619 (ANL-CT—78-40)
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Calculations on isotope separation by laser induced photodissociation of polyatomic molecules. Progress report, February 1, 1977—June 30, 1978, 4:1144 (COO—4294-1)

Army Engineer Div., Huntsville, AL (USA)
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Evaluation of a nuclease-resistant derivative of poly(i) poly(c) (poly(iclc)) as a radioprotective agent 1, 2. Interim report, 4:1486 (AD-A—051580)

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Some applications of solar energy in Thailand. Research report No. 61, 4:462 (NP—22862)

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Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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CONF-771184-	(American Pulpwood Association, Southeastern Technical Division meeting, Jacksonville, FL, USA, Nov 1977)	
1	4:1450	Dep. NTIS, PC A02/MF A01
CONF-771245-	(1. workshop on energy efficiency education through technology transfer, Washington, DC, USA, 15-16 Dec 1977)	
	4:839	Dep. NTIS, PC A06/MF A01
CONF-771254-	(9. Caribbean chemical conference, San Juan, PR, USA, 8-11 Dec 1977)	
1	4:1149	*See* UCLA-12-1149
CONF-771256-	(Insulation meeting, Washington, DC, USA, 16 Dec 1977)	
	4:902	Dep. NTIS, PC A04/MF A01
CONF-780117-	(Solar neutrino conference, Upton, NY, USA, 5-7 Jan 1978)	
2	4:1604	*See* BNL-24674
CONF-780132-	(Conference on DOR role in support of small scale appropriate distribution technology, Washington, DC, USA, 26 Jan 1978)	
	4:813	Dep. NTIS, PC A08/MF A01
CONF-780147-	(3. conference of the SAS users group, Las Vegas, NV, USA, 30 Jan-1 Feb 1978)	
1	4:1361	Dep. NTIS, PC A02/MF A01
CONF-7801143-	(DOE resource recovery project financing workshop, Washington, DC, USA, 17 Jan 1978)	
	4:825	Dep. NTIS, PC A03/MF A01
CONF-780203-	(1. joint U.S./Japan LMFBR steam generator seminar, Tokyo, Japan, 13-24 Feb 1978)	
6	4:622	*See* CRBRP-GEFR-SP-00043
CONF-780213-	(107. AIME meeting, Denver, CO, USA, 26 Feb-2 Mar 1978)	
13	4:994	Dep. NTIS, PC A02/MF A01
CONF-780232-	(IAEA meeting on sodium removal and decontamination, Richland, WA, USA, 14-16 Feb 1978)	
2	4:640	*See* HEDL-SA-1444
CONF-780236-	(5. OETC conference, Miami, FL, USA, 20-22 Feb 1978)	
2	4:440	Inst. of Gas Technology, Chicago, IL
CONF-780247-	(Meeting for the advancement of science, Washington, DC, USA, 16 Feb 1978)	
1	4:972	Ford Motor Co., Dearborn, MI
CONF-780308-	(NACE meeting on corrosion, Houston, TX, USA, 6-10 Mar 1978)	
8	4:636	*See* HEDL-SA-1420
CONF-780314-	(9. lunar science conference, Houston, TX, USA, Mar 1978)	
5	4:1618	*See* LA-UR-78-1358
CONF-780318-	(2. conference on high-temperature plasma diagnostics, Santa Fe, NM, USA, 1-3 Mar 1978)	
1	4:1961	*See* UCRL-81156
CONF-780338-	(3. conference on new results in high energy physics, Nashville, TN, USA, 6-8 Mar 1978)	
7	4:1732	*See* COO-1428-449
CONF-780353-	(13. high energy hadronic interactions sessions, Les Arcs, France, 12-24 Mar 1978)	
3	4:1702	*See* BNL-24536
3	4:1799	*See* SLAC-PUB-2134
CONF-780406-	(59. AWS annual meeting, New Orleans, LA, USA, 3-7 Apr 1978)	
4	4:633	*See* HEDL-SA-1343
CONF-780415-	(Scanning electron microscopy conference, Los Angeles, CA, USA, 16-21 Apr 1978)	
4	4:986	*See* LBL-7656
CONF-780453-	(Neutrinos, West Lafayette, IN, USA, 28 Apr-2 May 1978)	
9	4:1704	*See* BNL-24664
10	4:1703	*See* BNL-24663
12	4:1706	*See* SLAC-PUB-2138
CONF-780460-	(11. oil shale symposium, Golden, CO, USA, 11-14 Apr 1978)	
3	4:316	Dep. NTIS, PC A03/MF A01
CONF-780475-	(Controlled fusion theory conference, Gatlinburg, TN, USA, 26-28 Apr 1978)	
1	4:1979	Dep. NTIS, PC A02/MF A01
CONF-780476-	(3. conference on application of solar energy, Huntsville, AL, USA, 17-19 Apr 1978)	
2	4:903	*See* COO-1340-60
CONF-780481-	(Workshop on measurement technology and characterization of primary sulfur oxides emission from combustion sources, Southern Pines, NC, USA, 24-26 Apr 1978)	
1	4:1312	*See* BNL-24366
2	4:1313	*See* BNL-24367
CONF-780488-	(6. conference on automated cytology, Elmau, F.R. Germany, 23-29 Apr 1978)	
1	4:1446	*See* LA-UR-78-2001
2	4:1443	*See* LA-UR-78-1605
4	4:1444	*See* LA-UR-78-1658
5	4:1445	*See* LA-UR-78-1769
CONF-780491-	(Symposium on fusion energy, Montreal, Quebec, Canada, 11-12 Apr 1978)	
1	4:2053	Dep. NTIS, PC A02/MF A01

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CONF-780508-	(3. meeting on the technology of controlled thermonuclear fusion, Santa Fe, NM, USA, 9-11 May 1978)	
46	4:2062	*See* UCRL-80566
58	4:395	*See* BNL-24566
59	4:2100	Dep. NTIS, PC A02/MF A01
61	4:2093	*See* LA-UR-78-1627
63	4:2092	*See* LA-UR-78-1457
CONF-780520-	(2. thermophysics and heat transfer conference, Palo Alto, CA, USA, 24-27 May 1978)	
5	4:807	*See* PNL-SA-6587
CONF-780534-	(6. symposium on microdosimetry, Brussels, Belgium, May 1978)	
5	4:1900	Dep. NTIS, PC A02/MF A01
CONF-780541-	(Criteria for evaluating the biological efforts, Paskeut, USSR, 15-25 May 1978)	
1	4:1564	Dep. NTIS, PC A02/MF A01
CONF-780545-	(Meeting of the American Ceramic Society, Detroit, MI, USA, 6-11 May 1978)	
7	4:759	*See* HEDL-SA-1407
CONF-780549-	(Symposium on biotechnology in energy production, Gatlinburg, TN, USA, 10-12 May 1978)	
5	4:1230	Dep. NTIS, PC A02/MF A01
CONF-780553-	(American Gas Association Transmission conference, Montreal, Canada, 8-10 May 1978)	
1	4:172	Institute of Gas Technology, Chicago, IL
CONF-780564-	(5. international salt symposium, Hamburg, F.R. Germany, 29 May-1 Jun 1978)	
2	4:1581	*See* Y/OWI/TM-32
CONF-780571-	(153. meeting of the Electrochemical Society, Seattle, WA, USA, 21-26 May 1978)	
3	4:401	Institute of Gas Technology, Chicago, IL
CONF-780579-	(Meeting on picosecond phenomena, Hilton Head, SC, USA, 24-26 May 1978)	
5	4:1961	*See* UCRL-81156
6	4:1255	*See* SLAC-PUB-2150
CONF-780588-	(Information meeting, Princeton, NJ, USA, 9-10 May 1978)	
	4:2057	*See* PPPL-1441
CONF-780598-	(Symposium on solar-terrestrial physics, Innstruck, Austria, 29 May-10 Jun 1978)	
1	4:1630	*See* LA-UR-78-1640
CONF-780599-	(CAES technology symposium, Pacific Grove, CA, USA, 15-17 May 1978)	
1	4:806	Dep. NTIS, PC A03/MF A01
CONF-7805101-	(26. conference on mass spectrometry and allied topics, St. Louis, MO, USA, 28 May-2 Jun 1978)	
1	4:1035	Dep. NTIS, MF A01
CONF-7805104-	(Workshop on magma/hydrothermal drilling and instrumentation, Albuquerque, NM, USA, 31 May-2 Jun 1978)	
(Summ.)	4:517	*See* SAND-78-1365C
CONF-780606-	(Institute of Nuclear Materials Management meeting, Cincinnati, OH, USA, 27-29 Jun 1978)	
19	4:356	*See* SAND-78-1262
CONF-780609-	(ASME/CSME pressure vessels and piping conference, Montreal, Canada, 25-29 Jun 1978)	
15	4:720	*See* HEDL-SA-1354-FP
16	4:362	*See* HEDL-SA-1424
17	4:1015	*See* HEDL-SA-1332
CONF-780611-	(AIChE symposium, Philadelphia, PA, USA, 4-8 Jun 1978)	
12	4:118	Dep. NTIS, PC A03/MF A01
CONF-780612-	(Symposium on advances in radiation protection monitoring, Stockholm, Sweden, 26-30 Jun 1978)	
9	4:1261	*See* IAEA-SM-229/105
CONF-780614-	(8. conference on numerical simulation plasma, Monterey, CA, USA, 28-30 Jun 1978)	
1	4:1992	*See* UCRL-81103
CONF-780619-	(IEEE photovoltaic specialists conference, Washington, DC, USA, 5-8 Jun 1978)	
14	4:422	*See* SAND-78-0955C
15	4:423	*See* SAND-78-1277C
16	4:416	Dep. NTIS, PC A02/MF A01
CONF-780622-	(ANS annual meeting, San Diego, CA, USA, 18-23 Jun 1978)	
18	4:789	*See* SAND-78-0184C
62	4:642	*See* HEDL-SA-1477
63	4:721	*See* HEDL-SA-1485
71	4:722	*See* HEDL-SA-1504-FP
CONF-780631-	(12. conference on trace substances, Columbia, MO, USA, 5-8 Jun 1978)	
2	4:1376	Dep. NTIS, PC A02/MF A01
CONF-780642-	(Conference on bone mineral measurement, Toronto, Canada, 1-3 Jun 1978)	
2	4:1452	*See* BNL-24458
CONF-780644-	(3. conference on clustering aspects of nuclear structure and nuclear reactions, Winnipeg, Canada, 19-23 Jun 1978)	
3	4:1829	*See* LA-UR-78-1577
CONF-780650-	(1. symposium on ultrasonic materials characterization, Gaithersburg, MD, USA, 7-9 Jun 1978)	
6	4:985	Dep. NTIS, PC A02/MF A01
7	4:1908	*See* LA-UR-78-1603
CONF-780666-	(Conference on fundamentals of tribology, Cambridge, MA, USA, 19-23 Jun 1978)	
2	4:1016	*See* LBL-7328
CONF-780667-	(Symposium on solar energy, Cairo, Egypt, 16-22 Jun 1978)	
3	4:456	*See* LA-UR-78-1878
4	4:904	*See* LBL-7826
CONF-780670-	(Symposium on solitons, Goteborg, Sweden, 12 Jun 1978)	
1	4:1779	*See* CU-TP-123
CONF-780671-	(NSF site characterization workshop, Evanston, IL, USA, 12-14 Jun 1978)	
1	4:1284	*See* UCRL-81294
CONF-780672-	(Tissue culture meeting, Denver, CO, USA, 5-8 Jun 1978)	
1	4:1477	Dep. NTIS, PC A03/MF A01
CONF-780676-	(13. pulse power modulator symposium, Buffalo, NY, USA, 20-22 Jun 1978)	
1	4:2080	*See* SAND-78-0933C
CONF-780677-	(U.S. Japanese information exchange, Richland, WA, USA, Jun 1978)	
3	4:639	*See* HEDL-SA-1433
4	4:638	*See* HEDL-SA-1432
5	4:723	*See* HEDL-SA-1517
6	4:637	*See* HEDL-SA-1425
CONF-780679-	(JOPWOG-6/SubWOG-268 meeting, Albuquerque, NM, USA, 27-30 Jun 1978)	
2	4:1959	*See* SAND-78-1344C
CONF-780683-	(Passenger car meeting, Troy, MI, USA, 5-9 Jun 1978)	
1	4:949	Warrendale, PA; Society of Automotive Engineers, Inc. (1978). $2.50
CONF-780684-	(Meeting of the New York Academy of Sciences, New York, NY, USA, 22-27 Jun 1978)	
1	4:1431	Dep. NTIS, PC A02/MF A01
CONF-780685-	(Symposium on nonlinear structure and dynamics in condensed matter, Oxford, UK, 27-29 Jun 1978)	
1	4:1115	*See* BNL-24554
CONF-780686-	(20. electronic materials conference, Santa Barbara, CA, USA, 28-30 Jun 1978)	
1	4:1094	*See* SAND-78-0404C
CONF-780687-	(Mathematical and computational aspects of scattering theory meeting, Ontario, Canada, Jun 1978)	
1	4:1663	*See* LA-UR-78-1948
CONF-780690-	(Conference on current problems in stellar pulsation instabilities, Greenbelt, MD, USA, 1-2 Jun 1978)	
1	4:1588	*See* LA-UR-78-1511
CONF-780693-	(Workshop on interacting boson model, Erice, Italy, 5-9 Jun 1978)	
1	4:1888	Dep. NTIS, PC A02/MF A01
CONF-780694-	(Symposium of quantitative biology, Cold Spring Harbor, NY, USA, 1-7 Jun 1978)	
1	4:1484	*See* BNL-24539
CONF-780695-	(Neutral beam workshop, Abingdon, Oxon, UK, 26-30 Jun 1978)	
1	4:2083	*See* BNL-24561
CONF-780698-	(Northwest computer conference, Victoria, Canada, 15-16 Jun 1978)	
1	4:760	*See* HEDL-SA-1525-FP

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CONF-780699-		(5. meeting on the biological effects of bile acids, Freiburg, F.R. Germany, 12-14 Jun 1978)
1	4:1138	Dep. NTIS, PC A02/MF A01
CONF-780701-		(Conference on the energy solar updates, Atlanta, GA, USA, 12-14 Jul 1978)
1	4:444	*See* ANL/EES-CP-14
CONF-780706-		(6. pyrotechnics seminar, Estes Park, CO, USA, 17-21 Jul 1978)
14	4:1289	*See* MLM-2552(OP)
17	4:1290	*See* MLM-2553(OP)
CONF-780707-		(IEEE radiation effects conference, Albuquerque, NM, USA, 18-21 Jul 1978)
1	4:1273	*See* SAND-78-0575C
CONF-780708-		(Geothermal Resources Council meeting, Hilo, HI, USA, 25-28 Jul 1978)
10	4:510	*See* UCRL-80945
CONF-780718-		(7. cryogenic engineering conference, South Kensington, London, UK, 4-7 Jul 1978)
4	4:1159	*See* LBL-7934
CONF-780722-		(9. symposium on effects of radiation in structural materials, Richland, WA, USA, 10-14 Jul 1978)
6	4:641	*See* HEDL-SA-1455
7	4:635	*See* HEDL-SA-1405
9	4:1086	Dep. NTIS, PC A02/MF A01
10	4:1087	Dep. NTIS, PC A02/MF A01
CONF-780723-		(4. underground coal conversion symposium, Steamboat Springs, CO, USA, 17-20 Jul 1978)
6	4:103	Dep. NTIS, PC A02/MF A01
CONF-780726-		(3. conference on rapid quenching, Brighton, UK, 3-7 Jul 1978)
1	4:1116	*See* LA-UR-78-1865
CONF-780732-		(Metallographic Society Technical conference, Montreal, Canada, 16-19 Jul 1978)
3	4:71	Dep. NTIS, PC A03/MF A01
CONF-780733-		(3. workshop on laser velocimetry, West Lafayette, IN, USA, 11-13 Jul 1978)
1	4:1151	*See* LBL-7843
CONF-780734-		(Workshop on analytical electron microscopy, Ithaca, NY, USA, 24-28 Jul 1978)
4	4:1274	Dep. NTIS, PC A02/MF A01
CONF-780740-		(Management, stabilization, and environmental impact of uranium mill trailings, Albuquerque, NM, USA, 24-28 Jul 1978)
1	4:1421	Dep. NTIS, PC A02/MF A01
CONF-780742-		(Turbulent forces convection in channels and rod bundles, Istanbul, Turkey, 20 Jul-3 Aug 1978)
1	4:692	Dep. NTIS, PC A02/MF A01
CONF-780744-		(1. conference on energy and community development, Athens, Greece, 10-15 Jul 1978)
1	4:837	*See* ANL/EES-CP-18
CONF-780804-		(13. congress on high-speed photography and photonics, Tokyo, Japan, 20-25 Aug 1978)
4	4:1224	*See* LA-UR-78-1512
CONF-780807-		(2. world hydrogen energy conference, Zurich, Switzerland, 21-24 Aug 1978)
7	4:511	*See* SAND-76-5755C
CONF-780808-		(Meeting of the American Section of the International Solar Energy Society, Denver, CO, USA, 28-31 Aug 1978)
5	4:465	*See* SAND-78-0140C
7	4:455	*See* LA-UR-78-1631
9	4:457	*See* SAND-78-1241C
11	4:464	*See* LBL-6691(Rev.)
12	4:445	*See* BNL-24517
13	4:447	*See* BNL-24579
14	4:446	*See* BNL-24573
15	4:454	*See* LA-UR-78-1571
16	4:434	*See* SAND-78-0956C
CONF-780811-		(7. conference on plasma physics and control, Innsbruck, Austria, 23-31 Aug 1978)
5	4:1985	*See* LA-UR-78-1963
8	4:1935	*See* LA-UR-78-717
10	4:1937	*See* LBL-7298
11	4:2054	*See* LBL-7500
13	4:1936	*See* LA-UR-78-1914
15	4:2084	*See* LBL-7955
CONF-780813-		(Symposium on high pressures, Paris, France, 22-24 Aug 1978)
2	4:1291	*See* SAND-78-0035C
3	4:1298	*See* UCRL-80486
4	4:1295	*See* UCID-80470
5	4:1296	*See* UCRL-80440
6	4:1297	*See* UCRL-80457
CONF-780817-		(North American masonry conference, Boulder, CO, USA, 14-16 Aug 1978)
1	4:1155	*See* Y/EN-199
CONF-780818-		(Electron microscopy conference, Toronto, Canada, 1-9 Aug 1978)
7	4:995	Dep. NTIS, PC A02/MF A01
9	4:999	*See* LBL-7677
CONF-780819-		(15. nuclear air cleaning conference, Boston, MA, USA, Aug 1978)
12	4:361	Dep. NTIS, PC A02/MF A01
13	4:756	Dep. NTIS, PC A03/MF A01
17	4:366	*See* MLM-2545(OP)
20	4:1315	Dep. NTIS, MF A01
21	4:338	*See* DP-MS-78-7
22	4:339	*See* DP-MS-78-17
23	4:1164	Dep. NTIS, PC A02/MF A01
CONF-780823-		(Conference on the electronic structure of the actinides, Grenoble, France, 30 Aug-2 Sep 1978)
1	4:1038	*See* LA-UR-78-1857
2	4:997	*See* LA-UR-78-1762
CONF-780824-		(15. conference on low temperature physics, Grenoble, France, 23-29 Aug 1978)
2	4:1037	*See* IS-M-136
6	4:1907	*See* IS-M-135
7	4:1002	*See* SAND-78-0797
11	4:1921	*See* IS-M-132
CONF-780825-		(4. symposium on enhanced oil and gas recovery and improved drilling methods, Tulsa, OK, USA, 29-31 Aug 1978)
3	4:503	*See* LA-UR-78-1826
7	4:305	*See* LA-UR-78-1285
P1	4:205	Dep. NTIS, PC A19/MF A01
P2	4:233	Dep. NTIS, PC A13/MF A01
P3	4:294	Dep. NTIS, PC A18/MF A01
CONF-780826-		(19. conference on high energy physics, Tokyo, Japan, 23-31 Aug 1978)
2	4:1792	*See* COO-1545-238
3	4:1733	*See* COO-1545-237
CONF-780829-		(22. symposium and instrument display, San Diego, CA, USA, 28-31 Aug 1978)
1	4:1277	*See* LA-UR-78-2015
2	4:1954	*See* LA-UR-78-2060
CONF-780831-		(Symposium on group theoretical methods in mechanics, Novosibirsk, USSR, 25-29 Aug 1978)
1	4:1682	*See* LA-UR-78-757
CONF-780834-		(5. Bolton Landing conference, Lake George, NY, USA, 27-30 Aug 1978)
1	4:988	*See* RFP-2800
CONF-780836-		(20. congress ampere, Tallinn, USSR, 21-26 Aug 1978)
1	4:1117	*See* SAND-78-0499C
CONF-780902-		(American Chemical Society meeting, Miami, FL, USA, 10-15 Sep 1978)
6	4:109	*See* FE-EES-78/5
8	4:25	Dep. NTIS, PC A02/MF A01
CONF-780904-		(2. Pacific Basin conference, Tokyo, Japan, 24-29 Sep 1978)
1	4:388	*See* LA-UR-78-1147
2	4:359	*See* PNL-SA-7072
CONF-780906-		(Reversed field pinch workshop, Padua, Italy, 4-12 Sep 1978)
1	4:2008	*See* UCRL-81266
2	4:2007	*See* UCRL-81218
CONF-780907-		(4. conference on contamination, Washington, DC, USA, 10-14 Sep 1978)
2	4:1112	*See* SAND-78-0833C
CONF-780909-		(OCEANS, Washington, DC, USA, 6-8 Sep 1978)
1	4:1244	*See* SAND-78-0095C
CONF-780913-		(Colloque of physics of the metallic rare earths, St. Pierre De Chartreuse, France, 4-7 Sep 1978)
2	4:1118	*See* SAND-78-0751C
CONF-780914-		(International Society for Hybrid Microelectronics System, Minneapolis, MN, USA, 25-27 Sep 1978)
1	4:1039	*See* SAND-78-0401C
CONF-780917-		(WESCON meeting, Los Angeles, CA, USA, 12-14 Sep 1978)

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2	4:1279	*See* SAND-78-0644C
CONF-780919-		(14. conference on the physics of semiconductors, Edinburgh, UK, 4-8 Sep 1978)
1	4:1916	*See* LA-UR-78-1871
CONF-780920-		(Working party on stress corrosion cracking test methods, Firminy, France, 19-21 Sep 1978)
1	4:593	*See* BNL-24612
CONF-780921-		(Conference on neutron physics and other applied purposes, Harwell, UK, 25-29 Sep 1978)
1	4:1885	*See* COO-2479-14
CONF-780922-		(ASME conference on power generation, Dallas, TX, USA, 10-14 Sep 1978)
2	4:621	Dep. NTIS, PC A02/MF A01
CONF-780923-		(Fiber optics and communications exposition, Chicago, IL, USA, 6-8 Sep 1978)
1	4:1262	*See* LA-UR-78-1866
CONF-780926-		(3. symposium on neutron capture of gamma-ray spectroscopy, Upton, NY, USA, 18 Sep 1978)
1	4:1878	*See* UCRL-81498
3	4:1831	Dep. NTIS, PC A02/MF A01
CONF-781002-		(2. symposium on reactor dosimetry, Palo Alto, CA, USA, 3-7 Oct 1978)
1	4:634	*See* HEDL-SA-1375
CONF-781003-		(53. technical conference and exhibition, Houston, TX, USA, 1-4 Oct 1978)
1	4:53	*See* SAND-78-0591C
4	4:56	*See* UCRL-80921
CONF-781008-		(ASNT fall conference, Denver, CO, USA, 2-5 Oct 1978)
1	4:1272	*See* Y/DA-7702
COO-		
1198-1213	4:1036	Dep. NTIS, PC A08/MF A01
1340-60	4:903	Dep. NTIS, PC A02/MF A01
1428-449	4:1732	Dep. NTIS, PC A02/MF A01
1545-237	4:1733	Dep. NTIS, PC A02/MF A01
1545-238	4:1792	Dep. NTIS, PC A02/MF A01
2066-31	4:1491	Dep. NTIS, PC A02/MF A01
2185-11	4:1396	Dep. NTIS, PC A06/MF A01
2479-14	4:1885	Dep. NTIS, PC A02/MF A01
2621-2(EXEC.SUMM.)	4:528	Dep. NTIS, PC A02/MF A01
2633-3	4:952	Dep. NTIS, PC A09/MF A01
2641-5	4:441	Dep. NTIS, PC A04/MF A01
2689-9	4:1418	Dep. NTIS, PC A08/MF A01
2814-3	4:1485	Dep. NTIS, PC A02/MF A01
2904-9	4:26	Dep. NTIS, PC A02/MF A01
3064-5	4:1705	Dep. NTIS, MF A01
3084-61	4:1013	Dep. NTIS, PC A02/MF A01
3170-7	4:1932	Dep. NTIS, PC A16/MF A01
4051-24	4:513	Dep. NTIS, PC A02/MF A01
4094-6	4:417	Dep. NTIS, PC A03/MF A01
4115-24	4:1466	Dep. NTIS, MF A01
4120-2	4:536	Dep. NTIS, PC A06/MF A01
4246-5	4:1014	Dep. NTIS, PC A02/MF A01
4294-1	4:1144	Dep. NTIS, PC A03/MF A01
4337-1	4:925	Dep. NTIS, PC A09/MF A01
4493-3	4:950	Dep. NTIS, PC A02/MF A01
4533-1	4:1467	Dep. NTIS, PC A02/MF A01
4570-4	4:594	Dep. NTIS, PC A11/MF A01
4644-1	4:1662	Dep. NTIS, PC A02/MF A01
CRBRP-GEFR-SP-		
00043	4:622	AT
CRN-		
771122-00008	4:862	*See* DOE/EIA-0004/3
780301-00087	4:817	*See* PB-281815
780323-00121	4:872	*See* DOE/EIA-0044
780412-00156	4:869	*See* DOE/EIA-0041/2
780412-00157	4:870	*See* DOE/EIA-0041/3
780412-000158	4:873	*See* DOE/EIA-0048/2
780608-00238	4:860	*See* DOE/EIA-0004/1(78)
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0085	4:1019	NTIS, $5.25
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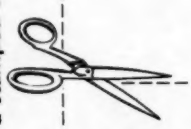

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